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INTEGRATED E-LEARNING PLATFORM FOR CHEMICAL ENGINEERING EDUCATION

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ABSTRACT. This contribution presents a running e-learning system for higher education in chemical engineering. The platform is structured in an administrative module and a teaching and evaluation module. Administratively, the faculty consists of several departments, organizing the student professional specializations. Special requests for the communication system are in place. The system is designed to allow further development towards large scale distance and continuous learning.

The main educational characteristic is complemented by the faculty organizational management. This refers to: academic records, timetable for students and academic staff, students examination and periodical assessment.

The strategy of developing specific chemical applications relayed on the conclusions of a large survey on the computer skills and attitude towards information technology assisted education. The survey was made within the academic staff and student population as well. Pilot topics were chosen to set up lectures and tutorials using the integrated e-learning platform.

Keywords: Chemical engineering education, e-learning, integrated platform, education management.

1. INTRODUCTION

Learning nowadays is a continuous and active process performed with a specified goal and applied to real life situations. Traditionally, the main criteria in selecting a higher education institution were connected with its prestige and location criteria. The location criteria are mainly connected to the life standards, and in Romania it played an important role. On the other hand, the prestige criterion brought many foreign students to the Romanian Universities. The globalisation process, reflected also in education, tends to amplify both criteria and a true education market has been created. Because of this, many academic institutions, find themselves in a situation of loosing some of their students in favour of other institutions, located at larger distances, but better anchored in the education market.

In Romania, development of infrastructure, communications and information systems and services represents a crucial condition for general economic development, as well as for integration in the European Union. Developing an education system through information and communication technology (ICT) could be the main approach to improve engineering education and to avoid the so-called "digital divide": people with low computer literacy are likely to have lower accessibility to information on the web than those with higher computer literacy. This would cause

a serious discrimination in the information society, as Internet is already a major source of knowledge and information in everyday life.

The industrial chemistry curriculum has a certain characteristic that makes it different from other technical courses: the higher amount of shared knowledge between different disciplines. By nature, an e-learning system allows modules from different disciplines to interact and complete one another (Kartan et al, 2002, Wanks, 1995, McCowan, 2002). For all these reasons, the faculty of Industrial Chemistry is the first higher education institution in Romania that developed an integrated e-learning system.

The e–learning platform in the Faculty of Industrial Chemistry was created during a joint project, involving University 'Politehnica' of Bucharest and SIVECO S.A.. This platform resulted from the adaptation of the Siveco commercial product, AEL, currently running in about 2000 high schools in Romania (Siveco).

Within this context we started our project of implementing an integrated e-learning system, with the specific objectives of

- developing the existing software environment – SeLFT,
- delivering straightforward procedures for SeLFT exploitation, addressing both student and academic users;
- content creation for teaching purposes.

This paper concentrates on the main characteristics of the e-learning system initiated in the Faculty of Industrial Chemistry, and the results obtained so far.

2. THE BASIC SYSTEM

Very often confusion is made between "e–learning" and "distance–learning". Distance learning can use the Internet, but also other teaching materials delivered by postal service. By e–learning it is generally understood a learning activity where ITC resources such as hardware resources (computers, video projectors, acquisition cards, etc) and/or software resources (simulators, interactive multimedia applications, e–books, etc) are involved. The use of Internet is not compulsory.

Computer aided education system may be focused on three different types of professor-student relationship:

1. "distance learning" model, where the education process is Internet supported. Although there is the advantage of a great flexibility in managing the students' time and material resources, there is the danger of depersonalising the educational process. Essential information may be lost in the feedback process when applying only a distance-learning type education model.
2. "face–to–face learning" model, assisted by ITC resources, characterised by extremely low flexibility and full social contact.
3. "combined" model, maximising the advantages of the previous two. It has a "face–to–face" component, since the professor participates physically in the classes, and a "distance" component supposing personal learning sessions outside the academic teaching schedule, and even in other locations. For the "distance" component the Internet, LANs, and CD-ROMs can be used as support.

Our e-learning system is based on the "combined" model. Therefore the platform is to be used by the students in the presence of the academic staff, in the virtual classroom (for lectures, certain laboratory activities and during the evaluation processes), and in their own time, to scroll through the applications available in the platform library.

The system offering both synchronous and asynchronous studying possibilities shows a series of features, such as:

- friendly, easily adaptable and differentiated upon roles interface,
- differentiated access of users depending on groups and roles, together with access privileges easy to manage.

The platform is based on several standards currently in use in the computer aided education community, such as the MathML, SCORM and IMS standards. During the development process Siveco has voted for portability and easy maintenance: they use a standard web–browser client application and an application server, based on the Java platform. High standard technologies are used (JDBC, JSP, Applets, XML). The content reusability concept is based on packaging description formats (in XML there are elements critical for importing and exporting according to the current standards in the field).

Actually the platform consists of three tiers:

- Database tier, offering all data managements services;
- Business tier (or LOGICAL tier), running the functional components (modules) and offering the users access to applications via local area networks or wide area networks.
- Thin clients tier, where several users access same application through a multithread process, while the application server runs the corresponding application and the database server provides the necessary data management services.

In terms of security such architecture offers certain advantages: an efficient management of users and groups of users (regarding mostly access rights to information/educational content for users or groups of users, according to files system principle) and well–defined access rights to functions (as they can be group upon roles and even the roles are configurable)

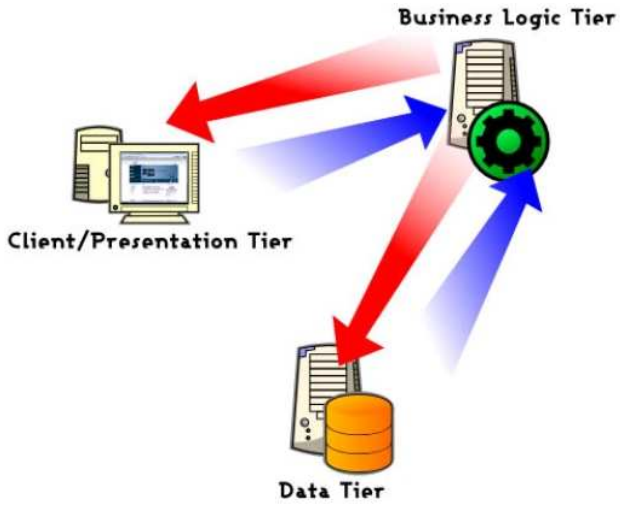

Figure 1. System Architecture

With its three tiers structure the system becomes extensible, scalable and distributed. The platform can be considered extensible since addition of new functions without disturbing those already in use and reorganizing the system data. Scalability should be understood in the sense that one dimension increase is accompanied by the automatic increase of the remaining dimensions (to ensure global compatibility). The scaling process may occur horizontally, as new machines are added and/or vertically, as new servers are added. The database and application servers allow connection of several instances running on different machines in the load balancing mode. Using one or several central databases servers, the platform shows its distributed character, as access is restricted by the administrator through the security module

3. THE MANAGEMENT SUBSYSTEM

The system architecture, benefiting from the features mentioned before, consists of a two-element system architecture: educational process management and content delivery. Both present similar importance for a faculty, training more than 1000 students for the technical field.

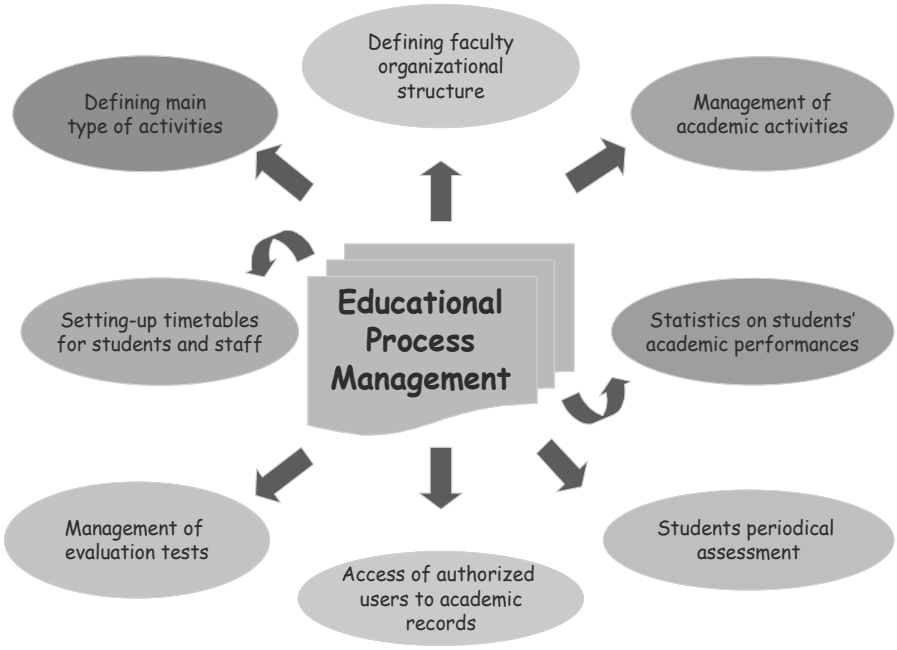

Figure 2. Administrative function of the e-learning system

The management features are briefly described in the figure 2. All aspects mentioned are fully covered by the platform, allowing students as well as faculty management to gain easy and instant access to academic records (figure 3), timetable (figure 4) or faculty structure (figure 5).

Figure 3. Access gate to full academic records of registered students

The database keeps full records on every evaluation test ever run with aid of the platform, offering the desired degree of transparency and fairness.

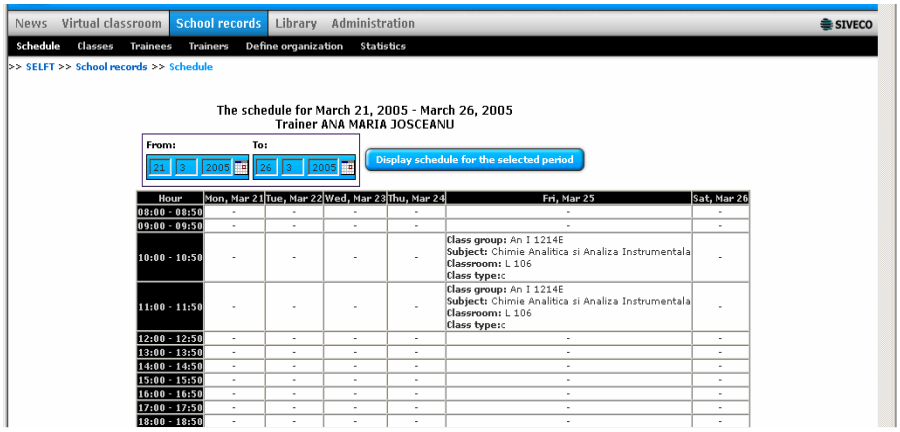

Figure 4. Timetable setting for the participants in the educational process.

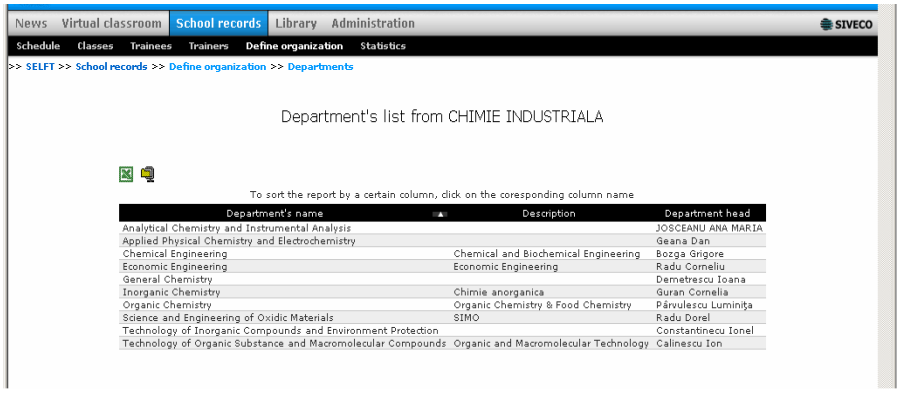

Figure 5. Faculty structure

4. CONTENT DELIVERY SUBSYSTEM

The content delivery subsystem consists of modules with a variable degree of interactivity as shown in figure 6. The virtual classroom is characterized by the largest degree of interactivity, thou many application for self study may show interactivity elements as well.

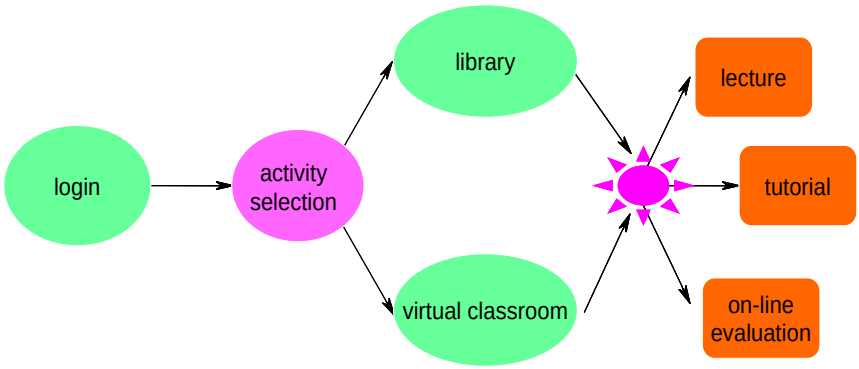

Figure 6. Choices in the content delivery subsystem.

Developing educational content is a tremendous challenge in front of the academic community. The content development team has adopted a special working policy: depending on each department's needs, the content managers develop general rules for content modules, while a small team with more expertise in Macromedia Authorware and other software develop complex procedures (Plesu et al, 2002, 2004). A library has been set up to solve two problems: a) efficient distribution of all activities between people, considering their experience level; b) avoiding redundancy in the content developing activity.

The following content modules have been defined for the e-learning integrated system:

- *Assisted course–type modules*

They are the most important modules, representing the basis of the content library as they have the important role to create fundamental knowledge as required by the curriculum. They are used in lecture theatres and locations designated for these activities (e–learning laboratories). These modules are accessible only during lectures, under academic staff supervision. The content delivery system is meant to be developed in Macromedia Authorware, especially for basic disciplines which are taught to a larger number of students.

Power Point presentations are also used for lecture type modules, mainly for special topics that are characterised by a high rate of content up-dating. These lectures are taught in the specialization years, for a smaller number of students, and often are optional courses. Figure 7 presents a possible selection from the "chemical

engineering" lecture packages, a lecture type module for "Technical thermodynamics". When selecting a lecture the user can also see some details, such as the name of the professor who created the application, the date, a brief description of the lecture, etc (see the window in the left upper corner of figure 7).

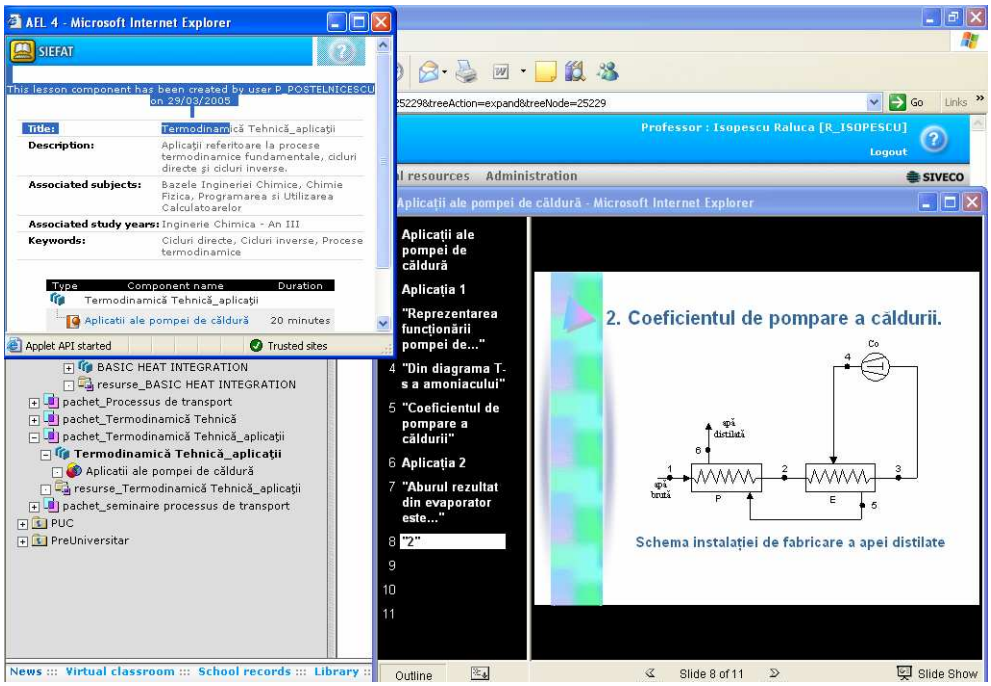

Figure 7. Assisted course type lecture in "Technical Thermodynamics"

- *Non–assisted course–type modules* follow the scenario of the assisted course modules, but are used for individual training. They include a large number of explanatory paragraphs, being available through the Internet, and other media (CD-ROM, floppy disk, etc.).

-*Tutorial-type modules* contain problems and applications and may be used both in classrooms (tutorials) and e–learning laboratories, as well as for individual study. Figure 8 presents a tutorial type module for technical thermodynamics. The application is an active simulation for a refrigeration system, which allows to choose automatically the parameters of the refrigerant using an interactive diagram.

- *Evaluation type modules* allow tracking the students' performances by the academic staff, as well as self–evaluations during the individual training stage (figure 9).

So far, we have implemented assisted course-type modules and seminar-type modules for basic topics as programming languages, analytical chemistry, numerical methods, applied thermodynamics, transport processes, unit operations and process simulation.

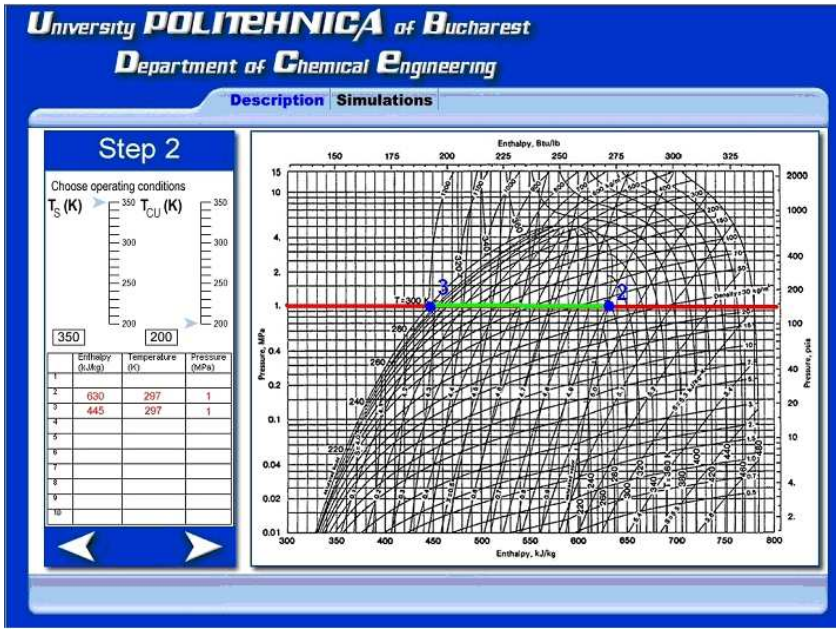

Figure 8. Interactive application for the description and simulationof a refrigerating system

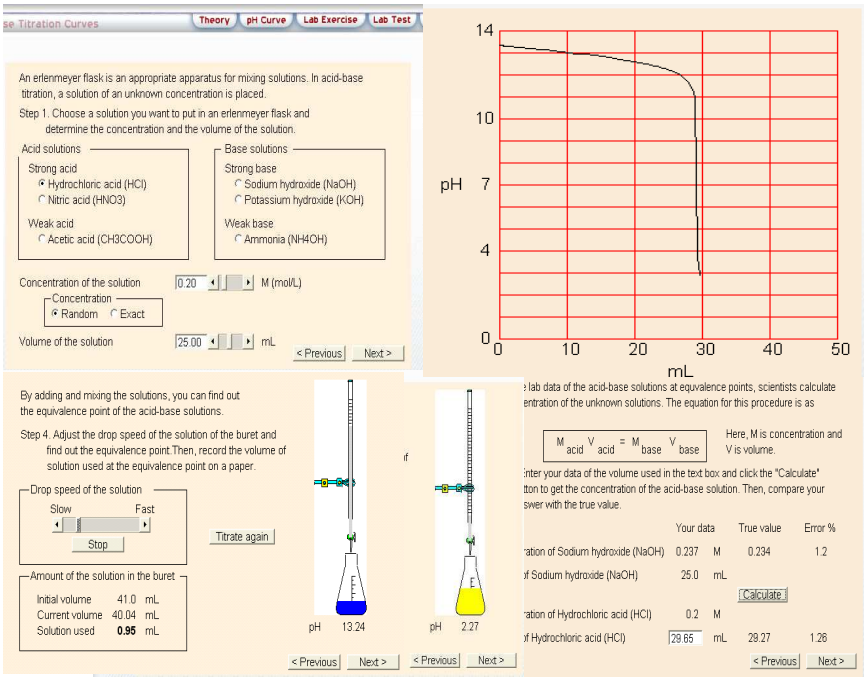

Figure 9. Interactive application for self evaluation in Analytical Chemistry.

5. STUDENT AND ACADEMIC STAFF FEEDBACK

Immediately after implementing the system, we launched a feedback questionnaire to the students directly involved in the "virtual classrooms". 70 % of the students declared their enthusiasm and appreciation for being able to gain instant access to test results, in terms of general score and selection of adequate answers. The rest of the students questioned either were not impressed (5 %) or found the on–line evaluation stressing (25 %). The last category included students with low computer literacy and interest. Most academics in our faculty (around 60 %) are still reluctant in changing significantly their teaching style, especially if they consider the time required to prepare an interactive lesson and to learn to use the e-learning platform. The team involved in this project is putting more and more effort in promoting the advantages of computer assisted education, being convinced that the new platform will fully demonstrate its value only if it is used extensively. Using such modern educational tools will give important opportunities to our faculty to promote efficient "life-long learning" and "distance learning" systems which became necessary in engineering education.

6. CONCLUSIONS

We have presented an already in use e-learning platform for a technical faculty that has administrative and educational functions. The system is still under development, and new features, according essentially to SCORM standards, were recently added. The complete system implementation will facilitate both educational process and the faculty management.

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