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Information and Communication Technology (ICT) and its Contribution to Teaching and Learning in Chemical Engineering

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The development of Information and Communication Technology (ICT) appears to be increasing in pace on a yearly basis. The development of new hardware, new communication methods, and software availability to exploit these new technologies, offers new opportunities in the education sector. The existing generation of learners quickly become conversant with the new technologies available, and are able to exploit them to their advantage. However, new technologies are far more slowly adopted by academic institutions, and it is usually not even clear how older technologies can be integrated into the curricula for the benefit of both learners and teachers. In addition, future employers also have a vested interest in graduating chemical engineers possessing a range of skills related to the use of commercially available software and technologies.
This paper examines some of the technologies that are being exploited for teaching and learning in Chemical Engineering at The University of Manchester, and in addition how the learning of required software and technology skills can be acquired. These include internet based technologies which are being used to host virtual learning environments, which are now able to support many learning based activities such as discussion boards, teaching and learning materials, student work submission, feedback, and grading. Skills in commercially available general software, such as word processing, presentations, and spreadsheets, are also required to be acquired by learners. Skills in mathematical modelling software packages and chemical engineering simulation packages also need to be integrated into the curriculum. In addition the paper will look at technologies not yet exploited specifically in chemical engineering at Manchester, but which are making impacts in engineering disciplines elsewhere.

1. Introduction

Teaching and learning in engineering disciplines has been required to respond to new developments in computer hardware, communications, and software availability, although many of developments have been outside of the direct influence of staff involved in teaching and learning. The most obvious of these reasons are (Perry and Bulatov 2010);

- Changing demands of the modern industry, most especially related to communication and collaborative/team working skills
- Increasing numbers of students applying for higher education, both at undergraduate and postgraduate level, and partly in response to the downturn in the global economy

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- Changing IT skill levels of students entering further and higher education, and familiarity and use of high technology products
- Changes from teacher-led to student centered learning and the availability of teaching materials away from the traditional clasroom

Consequently Engineering related disciplines are adopting new and emerging learning technologies and methodologies (Perry, 2002, Perry and Klemeš, 2004, Perry, 2006, Perry et al 2007) and also making use of new hardware platforms, such as mobile phones and the more recently developed iPads. Central to the adoption of new technologies is the increasing use of Virtual Learning Environments (VLE's), which are being used to distribute teaching and learning resources and to manage the teaching and learning process. Dillenbourg (2000) describes the main features of a VLE as;

- A designed Information Space.
- The provision of an environment where Educational interactions can take place, turning spaces into places.
- A place where information/social space is explicitly represented. The representation varies from text to 3D immersive worlds.
- A place where students are not only active, but also actors. They are able to co-construct the virtual space.
- A place that is not restricted to distance education, but can also enrich classroom activities.
- A place that can integrate heterogeneous technologies and multiple pedagogical approaches.

Examples of most popular VLEs are Blackboard (2010), WebCT (now part of Blackboard), and Moodle (2010).

2. Virtual Learning Environments

Virtual Learning Environments (VLE's), such as Blackboard and Moodle have become a standard tool in the tertiary education sector. These VLE's are made available so that resources required for particular needs are clustered in one place, and consequently teaching and learning resources are more easily managed. The use of VLE's in Chemical Engineering based education in The University of Manchester, UK, is shown in Figure 1.

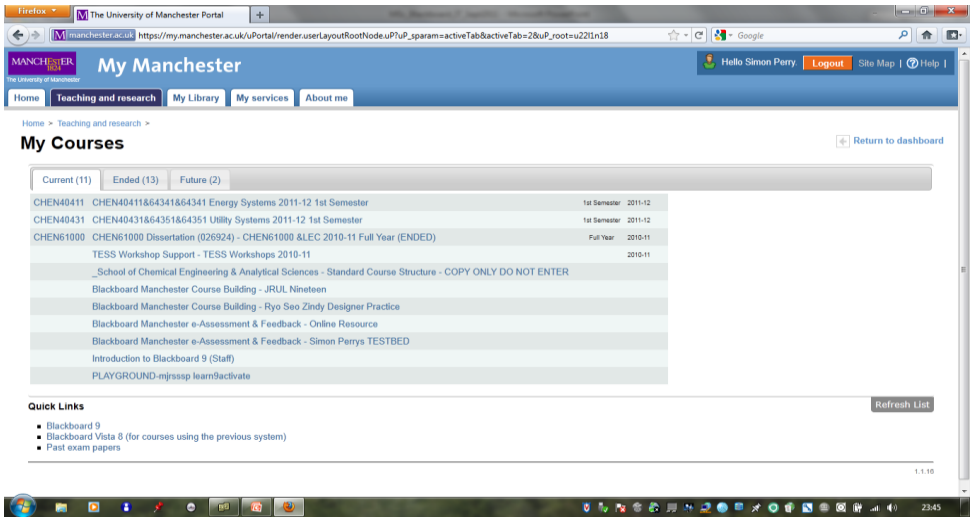

Figure 1. An example of the University of Manchester VLE

The advantage of the VLE is that resources associated with individual courses are readily available at all times, and that they can be accessed by both full-time students studying at the university and by students who are studying away from the institution, such as part-time distance learners.
In addition, VLE's can also be used to provide communication tools for academic staff to provide general notices about the progression of the unit and also more specific information to individual students or groups of students via Discussion Boards (Figure 2).

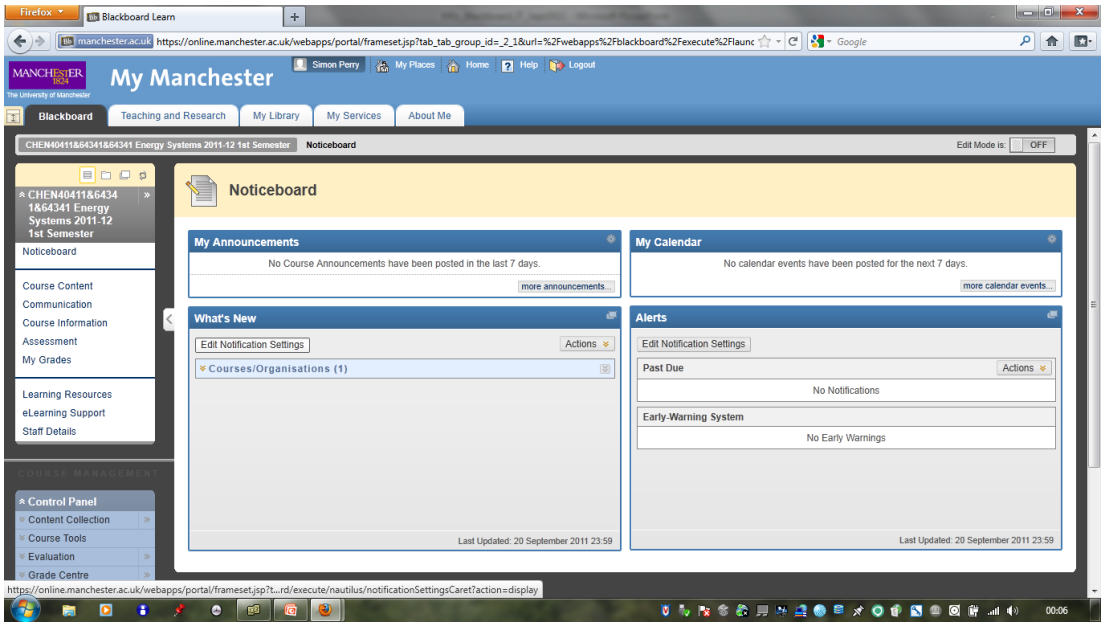

Figure 2. An example of a Noticeboard in a virtual learning environment (Blackboard)

3. Lecture Materials

The variety of hardware available to learners has made it possible to provide lecturing materials in a variety of formats in addition to the traditional paper based format. The recording of lectures, with both audio and video, is becoming common place, and at the University of Manchester many lecture theatres have been equipped with recording hardware. The methods described previously as Virtual Lectures (Perry 2002), and which involved recording audio off-line and then integrating with presentation slides, has now been superseded by technologies that are able to produce recorded lectures more rapidly. In fact, computer based technologies have now become so common place that recording lectures can be accomplished with readily available software such as Camtasia Studio (TechSmith 2012). Using this type of software and a radio microphone, lectures can be recorded directly from the computer being used to provide presentation slides, and then uploaded to a video server or a VLE (Figure 3). Software tools can also be used to edit the recording if necessary. These recorded lectures can also be termed Podcasts.

4. Assessment Tools

In a previous work (Perry et al, 2007) a method was demonstrated for the creation and delivery of an eAssessment in an undergraduate chemical engineering course unit. More recently Blackboard VLE tools have been used to create an eAssessment based on coursework undertaken in a postgraduate MSc course unit (Perry and Bulatov, 2010).
The coursework involved using bespoke simulation software which was made available to the students.

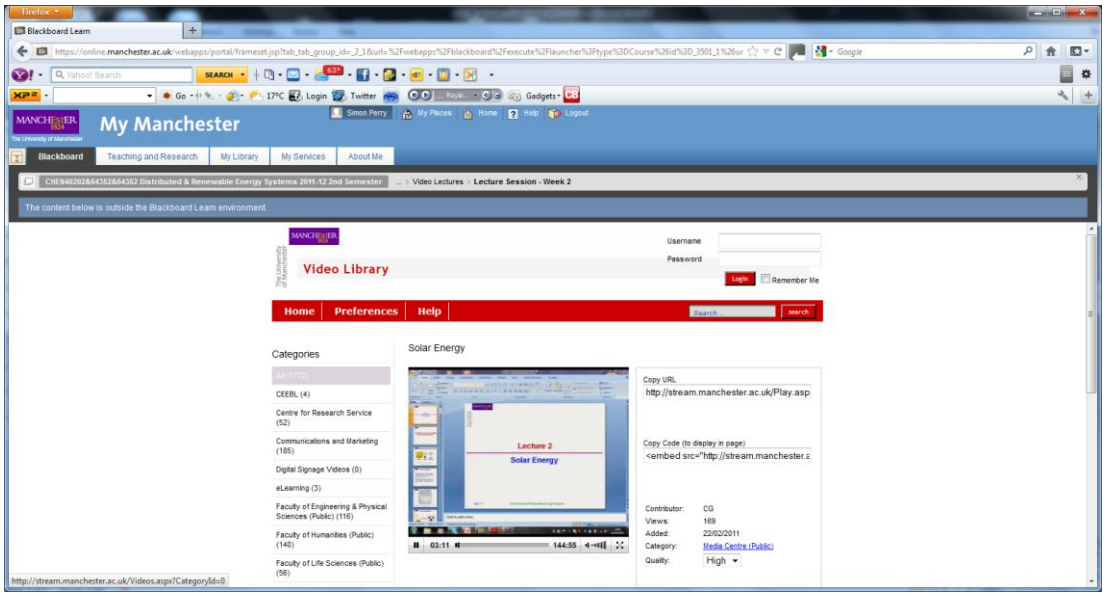

Figure 3. The use of Podcasts via a Video Library

An example of one of the courseworks for the Energy Systems unit is shown in Figure 4. Students were required to provide engineering solutions to the problems in the courseworks, to write and submit a report via Blackboard, and to undergo an eAssessment test related to work undertaken.

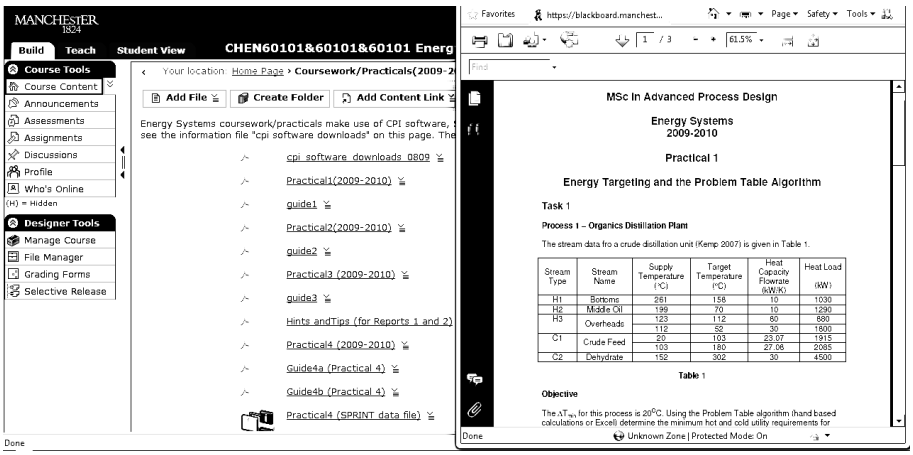

Figure 4. An Energy Systems unit coursework (Practical) posted in Blackboard

The eAssessment would allow instant feedback to students and therefore provide them with an objective evaluation of their knowledge and correctness of the solution to the problem stated in the coursework. In this prototype version the feedback to the student is rather brief, thereby making it a more summative rather than formative in nature. The types of questions used in the eAssessment varied from “multiple choice to “true/false”, “short answer”, “fill in the blank”, “matching” and “combination” types depending on which was most relevant.

To assist teaching staff in the task of recognizing plagiarism, various pieces of software have been developed. At the University of Manchester the software of choice is turnitinUK (Turnitin, 2012) , which is

either available as a stand-alone tool or can be integrated into the Blackboard VLE. A coursework assignment can be easily set up within the VLE, with various options available to assist the teaching staff with the task of plagiarism recognition. Submission dates can also be set, and the submission time recorded, to help with the management of the assignment. Although assignments can be submitted in a number of readily available formats, the production and use of pdf format has been found to provide the simplest and least problematic method as it avoids differences in native formats used by the large number of word processing packages used by students. Various features of turnitinUK can be used to assess the submitted work, the most powerful of which is the Originality Report. The Originality Report, summarised by the Similarity Index, provides the assessor with the instances in a student submission that corresponds to either other submitted work, or work that is available on the internet or other electronic resources. However, the findings of the report should be treated with certain amount of caution. It is possible that there are more than one instance of a student submitted report as the student is allowed to submit draft versions before the final deadline. The Similarity Index and Originality Report will indicate this as an instance of possible malpractice. Similarly, the submission may include the original questions required to be answered, and this will also be flagged by turnitinUK. Consequently any output from turnitinUK needs to be very carefully evaluated prior to any decision making as to the merit of the submitted work.

5. Simulation

Simulation software has long been a staple in Chemical Engineering curricula. Various commercial applications are provided to students by the University of Manchester, as well as in-house simulation packages. More recently there have been examples of Remote and Virtual Laboratories being developed. Cristea et al (2005) provided an example of remote experiments which are used in Process Control, Mathematical Modelling of Chemical Processes, and Advanced Control of Chemical Processes courses. Schofield and Lester (2010) reported on virtual chemical engineering simulations at the University of Nottingham, UK. The Virtual Absorption Column was developed to allow students to become familiar with the chemical process equipment and its operation. This allowed a good degree of familiarity before they encountered the equipment in the real laboratory. A second virtual laboratory has also been developed, but in this case is related to a continuous polymerisatioon plant. The aim of the virtual plant is for students to become familiar with large scale equipment, its integration and operation.

6. Conclusions

The advances in ICT over the last 10 years has allowed new teaching and learning resources to be developed and integrated with more traditional teaching and learning techniques and then to be distributed on a far larger scale.

The use of Virtual Learning Environments has made significant improvements in the management of teaching and learning resources, allowing academic staff to distribute materials when required in relation to the progression of their course, and also to monitor student progression and provide feedback when required. Access through the internet has allowed complete flexibility in the use of the Virtual Learning Environments, both for uploading and downloading resources.

Materials associated with teaching and learning has also become more dynamic. The ease of creating videos of traditional lectures with readily available and cheap equipment has allowed much greater flexibility in the teaching and learning process.

The development of assessment tools associated with Virtual Learning Environments has allowed greater flexibility in assessing student contributions and also allowed students to become more aware of the nature of academic malpractice.

Computer hardware and software platforms have also allowed the development of virtual chemical engineering worlds, which will allow students to become more familiar with the scale of real processing plants.

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