

Research and development of e-infrastructure to support students' learning

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Introduction

The Department of Industrial Engineering of the University of Santiago of Chile has twenty five hundred students and believes that, within the next decade or rather sooner, due to globalisation and information technology development, the Department will have a few hundreds students as local attendants. In contrast, there will be tens of thousands as virtual or distant students, from within and outside the country. Undoubtedly students will be learning using new methods and techniques, based on an e-infrastructure (Arias 2000).

With all this in mind, a research and development project was set out to manage and monitor the passing from the traditional to the new approach of conducting the teaching and learning process in the Department of Industrial Engineering.

The paper reports on the research and development to create an e-infrastructure to support the new departmental approach to teaching and learning. Firstly and briefly, it describes the research activities and operational model of students' learning used to build the e-infrastructure. Then, it presents the organisation of courses to implement the new approach.

Secondly and in more detailed, the paper describes the e-infrastructure developed. This is done in terms of the design of a synchronous/asynchronous web portal to support new course activities.

Finally, it presents some of the reactions of students regarding the use of the developed e-infrastructure.

The project

The project has had the following tasks: To constitute a human team, increasing in time, to conduct the new teaching and learning approach. To research about and communicate results of the new form to conduct the teaching and learning process, with both a departmental view and a significant use of information technologies. To update the departmental technological platform, including network, computer servers, personal computers and in particular the development of software tools as e-infrastructure. To prototype the new form of conducting the teaching and learning process in a couple of courses. To expand this new form to a dozen of courses and then consolidate it in a greater number of courses of the Department.

The present state of the project is in the transition period between the last two tasks.

Student learning model

Years of work with students have permitted to categorised student learning in two ways, students are either holistic or heuristic. Holistic ones tend to work from general to particular or detailed aspects. They need to feel confident before moving to another concept. Heuristic students tend to quickly grasp a concept, then move to different concepts, making relations among the concepts visited.

For both types of students, learning is viewed as experiential. According to Kolb (1991), learning takes place through a continuous and recurrent sequence of actual experiences and, as experiences for themselves are insufficient, they must be accompanied by thought, observation, abstract

concept construction and trying out these concepts in new experiences. This approach to teaching and learning also aids the development of skills, attitudes and values.

Course organisation

Unquestionably, in the new approach, courses must be organised through a fresher paradigm (Cervera & Gonzalez 1997), since it is not matter of passing old handouts to a web page (Rosemberg 2000).

The organisation of courses was borrowed from the works of Gagne and Kolb. Gagne et al (1992) points out that "learning is a permanent change of behaviour; which is result of, among others, exercises, training, revision and experiences, but it is not the result of physical o physiological changes". On another hand, teaching is the provision of conditions for learning and values, attitudes, social skills, etc. (Russell 1999).

Consequently, courses were organised in a new and different manner to provide students with opportunities for experiences, thoughts, observations, abstract concept construction and probe of new experiences.

For abstract conceptualisation there was an initial conference per course unit as well as reading of articles, papers and book chapters. For experiences and probe of new ones, students developed, throughout the course, a case study. For thought and deliberation there were two seminars per unit.

e-infrastructure

Information technologies, particularly those integrated to the web, adequately mixed into the educational practices, have ample possibilities not only to facilitate learning but also for its improvement and enlargement. All this allows students to be offered with access to more and updated information, being in contact with other students, educators and experts, sharing new electronic spaces and access to students and lecturers (Diapolo undated).

With the purpose of providing support to this type of teaching and learning, an e-infrastructure was analysed, designed and developed (Rumbaugh 1991, Page-Jones 2000). The e-infrastructure is a model, a tool, an engine and an administrator. It is a model of e-learning in that it supports the way holistic and heuristic students learn. It is an e-

learning tool because it allows lecturers to upload materials and activities and it provides students with access to those materials and activities. It is an e-learning engine since it links up client applications with web and data services and files in any format. It is an e-learning administrator in that it controls accesses, activates and deactivates access to asynchronous and synchronous tools and administrates student syllabus.

The visible appearance of the e-infrastructure is a web portal, which has synchronous and asynchronous functionality. The software tools associated to the web portal were built in three layers. The basic layer is constructed by an object relational database (Dorsey 1999) that administrates file locations, as well as students, syllabuses, courses, activities, assessments, lecturers, hits and others. The middle layer is built by the Apache server, which provides the web services. The logic of the tools is concentrated here. Communication with the other two layers is administrated as well. This server processes client requests and responds with html pages or with a Java class, which includes data and methods. The third layer is made up by a browser, which generates the client requests to the web server. The web server, through session administration, sends the clients data and methods in classes.

The e-infrastructure is made up of various software tools; two of the most important are the modules for lecturers and students. A significant feature of these two tools is the support for either mode of student learning. For lecturers, the tool, through simple dialog boxes, allows the uploading of activities and learning resources according to the three layers model for holistic students. For heuristic students the tool organises a table of contents with free navigation as well as a map of navigation. It follows a description of the module for lecturers and then the one for students.

The module for lecturers requests the definition of the list of contents via the provision of labels for chapters, sections and topics. Technically, this is done through an ordered and linked list. Next, the dialog moves to the contents for each of the topics previously defined. These are web pages prepared by the lecturers or their assistants or specially prepared by hypermedia professionals. Each web page may have up to three levels of depth, to be adjusted to the three-layer model. For each defined topic, there opens another dialog box, which asks for the name of the parent web page. The box has a button to examine the folder and file structure of the personal computer of the lecturer. The web server syntactically analyses the file, identifying

internal links and renaming them for definitive location in both the data server and file server. This is repeated for the three layers of the model.

Technically, and due to the necessary administration of various courses, several lectures, multiple students and manifold topics, this is done by the web server, which sends a class to the client. The class is named 'LecturerFile' and, among other attributes, it includes the identification of the lecturer and that of the course. Amid the methods there are the 'Parser', which performs the syntactical analysis and asks for the linked files; the 'FileSaver', which renames all files with a number generated by a saved procedure in the database, saves names and location in the database and save the file in the web server. Many formats are administrated, among them are 'htm', 'html', 'jpg', 'gif', 'bmp', 'asf', 'doc', 'xls', 'ppt', 'ps', 'pdf'. This is done recursively three times to accomplish with the model.

On its part, the students' module concentrates on the support developed for the flexible navigation organised for holistic and heuristic students.

For the holistic model, the web server administrates a session and sends a class with a list of all chapters, sections and topics previously defined by the lecturer. These materials are presented as a list of hierarchies. For the heuristic model, the class has a method, which permits students navigate through the materials freely, in any order.

Independently of the approach a student selects to navigate and to reflect the model, the materials are presented in three levels as follows:

- i. First level. It is presented a summary of main concepts of the topic and from here there is a link to a more detailed explanation of the concepts. Here the links can be to a variety of files in any format, it will only depends on the inventive of the lecturer. For example, there can be a link to a explanatory video or to an animation of the 'flash' type.
- ii. Second level. A concept is described in more detail and there can be links to various files, such as, text, video, animations and others.
- iii. Third level. There is access to the original materials supporting the presented concepts. It is possible that links, among others, be to other web sites, bibliographic references.

Students reactions

A formal evaluation was conducted on the first course run under the new e-infrastructure, which is reported elsewhere. From interviews and focus groups conducted to detect the strengths and weaknesses of the use of the e-infrastructure. These techniques also pointed to gather information on possible improvements to be introduced in future utilisation of the method. Accordingly, students' reactions are presented in two subsections: strengths and weaknesses.

Three main categories of strengths were found: the course and its structure, the e-infrastructure developed and the seminars.

Students said that the course organisation was good for them because the teaching team was made up of five people (one lecturer and four assistants). They pointed out that such a team is not usual in departmental practices and represented a good opportunity to have an enriched interaction. This allowed them to a better group work and in at ease manner. Students stated that the way in which the materials were prepared facilitated going through them, gave them the opportunity to better organise their time and plan activities of this and other courses. It was said by several students that the organisation of the assessment, with so many marks made it that individual mark had low impact in the final mark, which decreased pressure on single marked activity. Nearly all students mentioned that they would appreciate to have other courses likely organised.

The e-infrastructure was the item most mentioned by students in the interviews. For all of them, this was their first course to be based on an e-learning experience, which had extensive support of information technologies integrated to Internet. Students valued not to 'have to' go to the lecture theatre, and 'to go to class' at whatever time they could or had the opportunity, with the "materials there, as if they were waiting for me", as one student put it. It was also stressed that this gave them much autonomy and that this was not always possible to adequately manage. It was also repeatedly mentioned that the e-infrastructure had novelty of use, which produced a new sort of encouragement to revise the materials, that it was fairly easy to access the learning resources and that they gained a deeper knowledge.

The seminars organised every two weeks to control the advance of the practical assignment were very well considered. Typically, students said that they lost the fears to speak publicly, that with time they

became fairly confident to speak to the teaching group and peers. Equally, they appreciated that listening what the others had to say was interesting and a very useful experience.

Four categories of weaknesses were identified: the access to the e-infrastructure, the conferences, the work demanded and the tools used.

Two unexpected factors contributed to students' criticisms on the e-infrastructure availability. Firstly, it was up two weeks later than required. Secondly and unhappily, the University carried out electrical maintenance, which provoked many anxieties among students, who repeatedly said that the portal was not continuously up.

A few students were critical of the conferences given at the beginning of each unit, they pointed out that they 'missed' the traditional lectures and that the conferences were too few.

Students complied that the work was excessive compared with other courses and that there were a high number of activities in a reduced time. But when the course was dictated in the traditional form, students did complained for its demands on students' work.

Three software tools were used during the course. Their use provoked some acid comments since students felt that they had to learn to use them. This made the students say that the assistants did not give as much time as it was necessary to obtain a better grasp of such tools.

Conclusions

As we are reporting on a prototyping stage, any conclusions should to be regarded as tentative; these should be confirmed or changed after the new approach is conducted in more courses.

A robust e-infrastructure to support students' learning was developed and students have recognised that they had gained a deeper knowledge and that they would very much appreciate more courses in a similar format.

Students' reactions proved the authors' initial thesis, in the sense that the use of Kolb's concepts intensively supported by the e-infrastructure produced, overall, proactive students.

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