WEB SITE AND CONCEPT MAPS TO TEACH STATISTICS

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We constructed a web site to support service statistic courses at the University of Talca (http://dta.utalca.cl/estadistica/). The web site was developed around two fundamental ideas: object learning and concept maps. The statistical content was structured based on object learning organized around the scientific method. The object learning is imbedded in concept maps which highlight the structure and connections in statistics. Each concept map links complementary information in various formats. Students have positively evaluated the web page. This work was founded by the Education Ministry of Chile, MECESUP TAL0103 project: "Diversification of strategies for teaching and learning in basic sciences" (Diversificación de las estrategias de enseñanza-aprendizaje en las Ciencias Básicas).

INTRODUCTION

The University of Talca has been working along with its professors to include information technology in their classes. We became involved in a project related to the diversification of teaching and learning strategies in basic science classes. Statistics has been considered a basic science class in many careers' curricula, therefore it is taught in the first two years of the undergraduate degree programs in Chile.

The web site aims to serve as a complement to the statistics class, following ideas from blended learning, providing the students with material to enhance their learning experience. The contents are those typically covered in the service statistics course for different professional careers at the University; therefore, the site can be visited by all the students who are taking a statistics class, or by the students needing statistics help for their thesis work. This webpage usually goes along with statistics courses implemented in a web courseware (*WebCT*) available at the University, which is accessible only by those who are taking the class.

The nature of the project was that the instructor will not only be giving lectures, but would also facilitate learning by designing environments in which the students would engage in learning activities that help them construct their knowledge. In this paper we provide the setting for the project, we address web page issues, and we finish with a brief conclusion.

SETTING

Following last decade's tendencies in statistics education, the first step in this project was the examining of the syllabus content, primarily to convert the traditional lecture, into a more conceptual and data analysis oriented class. We reviewed several papers, but a necessary starting point was Cobb (1992). A big boost to our project was the contact with Dr. Martha Aliaga and her *Interactive Statistics* book (Aliaga and Gunderson, 2003). We changed our program from the traditional textbook sequence in the syllabus, i.e., descriptive statistics, probability, inference, and methods; to the scientific method approach presented in Aliaga and Gunderson's book, i.e., decisions with statistics, data production, type of studies, descriptive statistics, basis for inference, inference, and methods.

One important fact is that in Chile, for economic reasons, we cannot ask our students to buy textbooks for their classes. In addition, up-to-date statistics books are not translated into Spanish in a timely manner. Aliaga and Gunderson's book, the one we selected for our class, is not in Spanish. Consequently, we are constrained to either chose a Spanish statistics book and tell the library to get copies of it or to use our own lecture notes. It is customary that teachers use their own lecture notes for their classes; the problem with this practice is that, usually, the teacher writes his/her class notes on the blackboard, resulting in an extremely passive class. We decided to give the students the class notes in advance.

The next step in our project was to produce the class notes. Our class notes mainly were based on Aliaga's book and other textbooks; an important one to mention is Moore and McCabe (1999). Besides the class notes we produced exercise sets. Following Cobb's (1992) ideas, for the

exercises we gathered real world data meaningful for the Chilean context. For example, we are using data from the 2002 census; TV series data; newspapers data, University records data, government data, etc.

Keeping in mind the economic factors and the need for an interactive mode of teaching we opted for Web-based Instruction. In this teaching and learning modality, the Internet and their diverse tools, become a device that allow us to design, develop and implement a course or didactic materials to support the teaching and learning process. We should also mention that by the time this project started, in 2002, there was a notorious lack of statistical material in Spanish on the web. We should mention that around the same time, there was another project founded by the Education Ministry of Chile, geared to develop statistics material for students lead by Professor Jorge Galbiati (www.jorgegalbiati.cl) from the Catholic University of Valparaíso.

In the first year of the project, the students had access to the material before class via *WebCT*. Using *WebCT*, students are able to navigate through the course entries to review learning objectives; check assignment deadlines; go through the syllabus; and to find the resources connected to the course assignments. For teachers, *WebCT* is a powerful tool for administering the course; to store student grades; to send messages to the students; give assignments; upload exam answers, etc. Also, with *WebCT* students have the opportunity to ask questions to the teacher outside class time and office hours. An interesting paper addressing these kinds of issues is Malone and Bilder (2001).

A disadvantage with using *WebCT* was that we needed to upload the same documents for each statistics course (12 courses per semester), taking up a lot of space in the server. Another constraint was the restricted access to the material only for those signed up for the class. Therefore, we decided to create a repository of documents (notes and exercises) in a webpage. The webpage turned out to be a new place to give tools to students in several ways.

The statistics webpage provides the students with materials to enhance their learning experience, and serves as a teaching aid and a complement to the class. The website is organized as learning objects where concept maps are imbedded. Wiley (2000) defined learning objects as "any digital resource that can be reused to support learning." Examples of learning objects include multimedia content; instructional content; learning objectives; instructional software and software tools (LOM, 2000, mentioned in Wiley, 2000). This way, a learning object is a block of content that constitutes by itself an independent unit of learning of short duration. These small units or lessons can be added up to form modules or courses. In our case, the main characteristic of the learning object is its reusability, because it can be classified and kept in a database and be used again in other courses.

Concept maps are a technique for organizing knowledge graphically. Concept maps give the possibility to capture, process, and store information, in a way similar to that used by the brain. Concept maps carry out a schematic representation of significant relationships among concepts expressed as sentences. This technique was developed by Novak at the end of the seventies (Novak and Gowin, 1988) having as a theoretical foundation the theory of assimilation of Ausubel, based on the constructionist pattern of human knowledge. This theory describes how the student acquires concepts and organizes them in his/her cognitive structure. When the apprentice is able to relate the new concepts to previous knowledge within his/her own cognitive structure, learning takes place. Concept maps, the second element for organizing the contents of our Statistic webpage, can be considered themselves learning objects. There are authors in statistics that already are using concept maps in their work, see for example Bulmer (2002a,b) and Bond (2005).

The technique of concept maps allows to connect a series of concepts and to navigate through them, establishing their interrelations and linking them with contents and necessary didactic materials to improve students' understanding. In the webpage these contents and materials are presented in different digital formats (texts, hypertexts, simulation applets, images, audio, videotape, etc.). This situation allows us to derive two important benefits. In the first place, we can extract all the potentialities that hypermedia provides us. In the second place, we are able to put the course contents within easy reach of the students thus, addressing the students' different learning styles.

As mentioned before, each learning object has material in different formats. Following ideas from several authors, Webster, West, and Ogden (1998), among others we worked to incorporate simulation applets into the webpage. One problem with the applets available in the internet is once more, the language. We started to develop some applets using Flash software, following ideas from Holmes (2001). In the webpage we have three simulation applets, one to simulate the process of taking a sample from a population, and two applets to show properties of the mean and the standard deviation. We also used Descartes, a customizable kind of applet to show Normal distribution's properties, and correlation features. Finally we bought the commercial software Fathom, since the advantage of this software is that students can play, change parameters, and make their own applets.

WEB PAGE ISSUES

As we have already mentioned, the statistics web site was structured based on concept maps and learning objects. But, its primary conceptual structure is given by the scientific method. The scientific method and its stages are the organizing core of the contents represented by the concept maps. We state the four main stages of the scientific method, as in Aliaga and Gunderson (2002): formulate a theory, collect data to test the theory, summarize and interpret the results, and make a decision. Between summarizing and interpreting the results there is an intermediate step that provides the foundation of inferential statistics, i.e, probability, random variables, and sampling distributions. For each of the steps, concept maps were elaborated for the different sub-stages of the method that include lecture notes, proposed exercises, solved exercises, online questions, suggested bibliography, explicative hypertexts, simulations applets, SPSS tutorials, links of interest, videotapes, animations and other conceptual maps. See Figure 1 as an example.

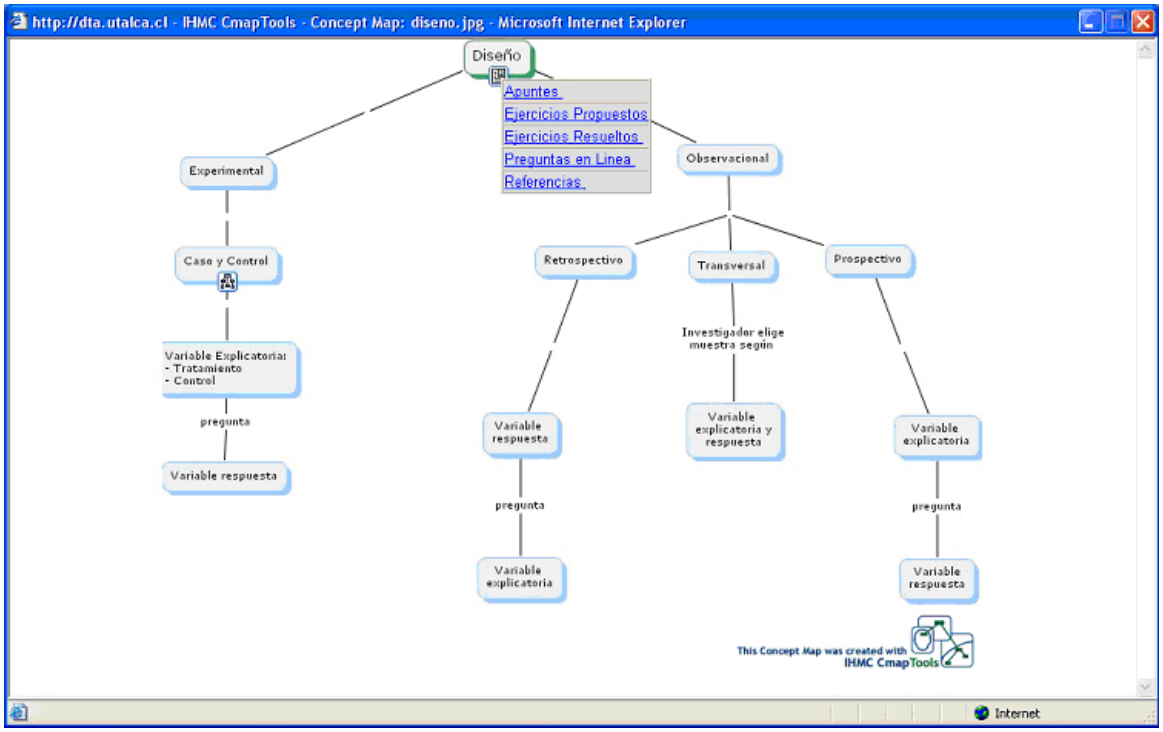

Figure 1: Concept map on type of studies and their annexed objects

To develop a data analysis course was fundamental to have a statistical package for the students; we chose *SPSS*. We developed *SPSS* tutorials to help the students to do their lab work without the presence of the instructor. In the past we had organized labs where the students worked in data analysis synchronically. This approach didn't work very well as it was very difficult to organize labs for large classes.

The Statistics web site is divided in the following sections (see Figure 2):

a) Home Page: this is where the web site is presented, the objectives that it seeks, its structure and contents are explained.
b) Introductory Unit: this section explains the relationship between statistics and the scientific method, and presents statistical applications in different disciplines. For this section, a videotape on the application of statistics in medical technology, a bibliography and web links to articles on this relationship are presented. The videotape follows ideas from *ActivStats* (Velleman, 2000).
c) *SPSS* Help: this area contains a tutorial on the use of the program *SPSS* (Statistical Package for Social the Sciences). This tutorial refers to specific tasks that the students need to accomplish with *SPSS* to solve the problems on the data analysis labs.
d) Scientific Method Stages: this section is divided into the four stages of the scientific method and its respective statistic thematic. These thematic are represented in the concept maps.
e) Site Map: the map of the site with all their sections.
f) Download: in this section we find a series of utilitarian software.
g) Contacts: this is a direct connection to the electronic mail of the site (estadistica@utalca.cl) to contact the author.
h) Credits: in this section appear the names of people that participated in the construction of the web site.

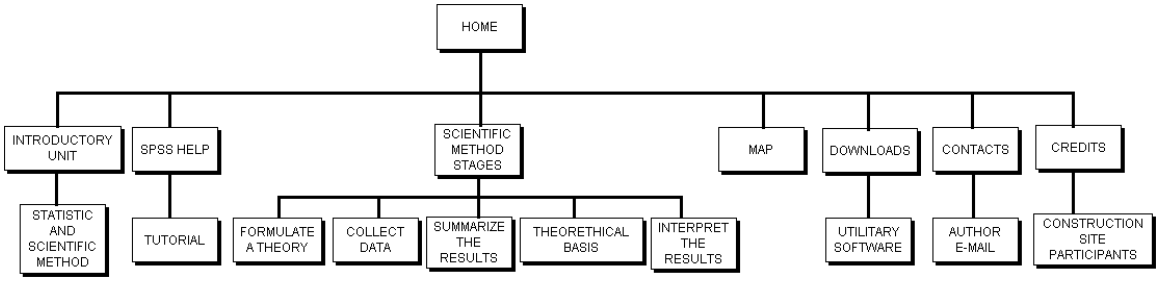

Figure 2: The structure of the Statistics web site

Different commercial and open source software were required to develop the site. The main programs used were:

- *Dreamweaver*: for the construction of the web site.
- *CmapTools*: for the elaboration of the concept maps.
- *Flash* and *Descartes*: to create simulations applets.
- *Hot-potatoes*: to create online questions.
- *RoboDemo*: to develop the *SPSS* tutorial.

We asked psychology students from 2005 statistics class, to evaluate the web trough a survey and they positively evaluated the web page in terms of navigability, visual presentation, and content organization. They also gave us some ideas about how to improve the page.

CONCLUSION

This project was important for us not only because of the incorporation of the web based instruction, but also as a way to use these tools that provides material to the students or everyone interested in statistics, at no cost. Other thing to mention is that we are providing statistical material in Spanish which lacks in the web.

Incorporating web-based instruction into service statistics class has been an enriching teaching and learning experience for both teachers and students. These tools are dynamic and, therefore, we are called to update and improve them continually.

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Descartes: http://descartes.cnice.mecd.es
Hot-*potatotes*: http://hotpot.uvic.ca
Flash, *RoboDemo*, and *Dreamweaver*: http://www.macromedia.com/
WebCT: http://www.WebCT.com
Fathom: http://www.keypress.com/fathom