A first approach to Self-learning statistics activities at the UPC

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Abstract—The European institutions of higher education have undertaken one of the most important educational reform movements in history. It represents an opportunity for renovation and improvement which will require profound reflection, perseverance and a common effort on the part of all those involved in higher education. The concepts and strategies defined in the Bologna Process to develop a European Higher Education Area (EHEA), involve a change in the educative programs. This change has to be adapted to innovative teaching and learning processes based on achieving specific knowledge according to the degree, and based on developing abilities and skills to adapt that knowledge to the professional field of work. Thus, the method has to be focused in the learning process (based in the student and his capability to learn) and not in the teaching process (based in the teacher work). In this paper, we will describe several experiences applied at the Universitat Politècnica de Catalunya (UPC). These experiences are based in the adaptation of the educational plans of Statistics subjects. Professors should have a new role, as guides in the students' learning process. Attention is focused in the increase of autonomous work that students will have to do using the "Self-Learning Activities" (SLA).

Keywords—Atenea , European Higher Education Area (EHEA), Self-Learning Activities (SLA), Statistics.

I. INTRODUCTION

THE Bologna process and its subsequent communiqués are central in the European drives for internationalization, collaboration and exchanges between higher educational institutions. This process is a mighty enterprise that encompasses most of Europe, and continues to expand geographically picking up new member states at each ministerial meeting. Originally, there were 29 signatory countries to the Bologna Declaration, and shortly thereafter Liechtenstein was retroactively added. Then in 2001 at the Prague conference, Cyprus, Croatia and Turkey joined. At the 2003 meeting in Berlin, seven more countries (Albania, Andorra, Bosnia & Herzegovina, Holy See, Russia, Serbia and Montenegro and Yugoslav Republic of Macedonia) were admitted bringing the number up to 40, number increased in

subsequent meetings. With Russia's membership, the Bologna Process now literally stretches from the Atlantic to the Pacific. When it is completed in 2010, the EHEA will include over 12 million students and 4,000 universities across Europe. An educational reform movement on such a grand scale has never before been attempted in Europe, or elsewhere for that matter.

The objectives of the EHEA are as follows (according to the Declaration of Bologna'99 followed by the Prague'01, Berlin'03, Bergen'05 and London'07 Statements [1], [2]):

a) Adoption of easily readable and comparable degrees;

b) Adoption of a system essentially based on two main cycles, undergraduate and graduate;

c) The establishment of a system of credits, such as the ECTS system, as a proper means of promoting the most widespread student mobility;

d) Promotion of mobility by overcoming obstacles to the effective exercise of free movement of students, teachers, researchers and administrative personnel;

e) Promotion of European co-operation in quality assurance with a view to developing comparable criteria and methodologies;

f) Promotion of the necessary European dimensions in higher education, particularly with regard to curricular development, inter-institutional co-operation, mobility schemes and integrated programs of study, training and research.

g) Lifelong Learning as an essential element to achieve an improved European competitiveness, social cohesion, equal opportunities and quality of life;

h) Promotion of the European Higher Education Area by means of the development of systems to ensure quality and of mechanisms of certification and accreditation.

What it involves:

• The desire to develop a common system of degree programs which will ensure the recognition and compatibility with the studies carried out in other countries.

• A thorough rethinking of the structure, content, degrees and materials which make up the university system.

• Revision of testing systems and methods.

• Transparent public accountability of systems and degree programs.

• Recognition of both academic and professional qualifications in order to better respond to the reality of a unified European labour market.

• Enhanced competitiveness in training and research.

• Increased mobility of students and professors.

- Improved competitiveness of university graduates.
- Quality accreditation.
- What is proposed is a Europe of knowledge, for the purpose of adapting higher education to life-long learning so that its citizens will be better capacitated to confront the changes and challenges of today's society.

In Spain, Universities are suffering a reform process in order to adapt themselves to the European Higher Education Area, which was formally defined after the Bologna Declaration. Through the "Ley Orgánica de Universidades" (LOU) [3], Spanish Government established the basis to adopt the required measures to integrate its system fully into the educational system of the EHEA. As a response to this commitment, in February 2003 the Ministry of Education published the framework document, "The integration of the Spanish university system in the European Higher Education Area" [4], which develops the principles committed in the LOU and it is a starting point for reform procedures in Spain. Finally, the Ministry of Education and Culture approved in September 2003 a Real Decreto [5] to establish the European credit and the European system of degrees before 1st October 2010. However, revisions of the legal framework, due to political reasons, have slowed the reform process. The "Modified Ley Orgánica de Universidades" (LOMLOU) [6], developed through several Real Decretos [7], establishes the current framework of the degree system in order to achieve the 2010 goal.

Important parts of this process involve several organizational changes to be made. It also implies technical and human resources to be supplied for teaching and learning. As adapting the EHEA requires carrying out changes in the design of the university degrees, it also needs the introduction of changes in the methodology of the educational plan of every subject in the degree as well as a good coordination between subjects. The design of educational plans has always played a central role in the daily work of teachers. Taking into account the deep relationship between the educational plans and the overall quality of Higher Education, the way that methodological changes are introduced in them is of a great importance for Higher Education to be on the correct way to excellence.

II. A NEW METHODOLOGY: FROM TEACHING TO LEARNING

Along with the new structure comes a complete overhaul of the teaching methods, with a new teaching and learning model being implemented within the framework of lifelong learning. This is to achieve new training objectives based around skills acquisition and the ability of students to continue studying (academic skills and professional skills). This is a system in which the number of hours of lectures will be reduced and in which more importance will be given to the whole learning process of the student. The student will learn in a different way and will be assessed in a more diverse way than exclusively through exams: it is the overall effort of the student that will count (assignments, studying, seminars, group work, tutorials, etc).

Lifelong learning is defined [8] "all learning activity undertaken throughout life, with the aim of improving knowledge, skills and competence, within a personal, civic, social and/or employment-related perspective".

Lifelong learning is therefore about:

- acquiring and updating all kinds of abilities, interests, knowledge and qualifications from the pre-school years to post-retirement. It contributes to the development of knowledge and competences that will enable each citizen to adapt to the knowledge-based society and actively participate in all circles of social and economic life, taking more control of his or her future.
- valuing all forms of learning, including: formal learning, such as a degree course followed at university; non-formal learning, such as vocational skills acquired at the workplace; and informal learning, such as inter-generational learning.

Lifelong learning is also about providing "second chances" to update basic skills and also offering learning opportunities at more advanced levels. All this means that formal systems of provision need to become much more open and flexible, so that such opportunities can truly be tailored to the needs of the learner, or indeed the potential learner.

In the framework of lifelong learning, self-learning activities are very important: Self-learning activities are defined in document "Marco para la revisión de estudios en la UPC" (Framework for studies revision at the UPC) (Vice-Management of Teaching and Research, UPC, January 2000, [9]) as: «Learning or teaching activity, with asynchron character, that does not require simultaneity in space and time of teacher and students. Then, it is related with activities of complementary work, planned and not done in the classroom. This work may be, or not, supported by ICT tools and done, or not, at distance, or at university's facilities».

Then, complementary assignments to presence activities should be proposed to students. Its objectives are:

- Incite the student to the self-learning of the subject and in general.
- Foster the access to complementary information in diverse supports: books, multimedia, video, etc.
- Consolidate the knowledge derived from presence activities.
- Encourage teamwork, which promotes the sense of responsibility, taking decisions, self and group criticism, etc.

Objectives should be exposed by the professor in a very explicit way in the presentation of these activities. At the same time, the professor must facilitate the access to the tools and necessary information for this activity type, as well as organize and control teamwork and show strategies in some cases [10]. It is important that students realize that learning goes beyond learning by heart and using formularies. The matter is not to learn by heart a collection of formulas, but to know how to interpret, compare, analyze and apply techniques and procedures learned in face-to-face theory, problems and

laboratory classes.

The evaluation system must be also established in advance. It must comprehend all learning activities, suitably weighted. Continuous assessment allows students to develop a critical attitude towards his/her learning. In contrast with traditional teaching system, where only a final exam was taken, continuous assessments allow students to realize when they are not doing very well and take measures. Partial results of the assessments should be discussed regularly with the professor, in small group meetings to foster interest.

Evaluation criteria must be established from the beginning, and related to the objectives. This provides a great amount of advantages. One of them is that students know the direction of their learning, so that they can assess their work and try to improve it if necessary, with the help and guidance of the professor.

III. THE VIRTUAL CAMPUS ATENEA

Atenea is the new e-learning environment for the Universitat Politècnica de Catalunya, developed using Open Source Software. Upcnet has adapted the Learning Management System Moodle to the specific needs of the UPC, giving rise to Atenea 4. Moodle is an open code for management of on-line teaching, an useful tool for any kind of teaching (presence/distance), in a social constructivism framework. Moreover, in addition to the educational virtues, the platform allows integration with other software used at the University, such as administrative or library software. Atenea's functional design has been carried out with professors and department contributions, with the objective of supporting adaptation of UPC studies to the guidelines of EHEA. Since September 2007, Atenea is running its version 4.4, based on Moodle 1.5.3. This version adds new useful tools, most of them suggested by users.

Moodle is a software package for producing internet-based courses and web sites. Moodle is provided freely as Open Source software (under the GNU Public License). It's an ongoing development project designed to support a social constructionist framework of education. Moodle is an active and evolving work in progress. Development was started in the 90's by Martin Dougiamas who continues to lead the project. A busy online community and plenty of information

Fig. 1 Virtual Campus Atenea

can be found at moodle.org [11].

IV. EXAMPLES OF SELF-LEARNING ACTIVITIES IN STATISTICS

In this section, two experiences of self-learning activities in Statistics are presented. Two points of view, from two different degrees in engineering, are shown: Industrial and Civil Engineering, taught at two different polytechnics (EUETIB and ETSECCP, UPC). Statistics for future industrial engineers (Mètodes Estadístics de l'Enginyeria) has credit recognition for self-learning assignments, whilst Probability and Statistics for future civil engineers considers self-learning assignments as a midterm assignment, which is considered in final qualifications but is not recognized as credits. Bologna reform should change this situation.

However, both situations pursue very similar objectives. Using different activities, class contents are reinforced, new contents are introduced and practical applications are shown. At the same time, relevant aspects of the subject linked to other subjects, or to engineering practice are introduced [12]. Knowledge is important, but attitudes and skills, are considered very valuable for engineering practice. Constructive criticism, scientific research and the use of suitable techniques and means are promoted.

Objectives:
- Solve an statistical problem, developing all its stages:
    - Problem formulation.
    - Data collection.
    - Preliminary data study.
    - Use of suitable statistical techniques.
    - Result assessment.
- Use of suitable graphical and mathematical/ statistical software.
- Write and present conclusions.
- Use basic references.

A. Self-Learning activities at EUETIB and ETSECCPB

Self-learning activities have been structured in several assignments:
   i.   People around us…
   ii.   Other interesting data...
   iii.   Let's compute illusions...
   iv.   Techniques nowadays...
   v.   And classical knowledge ...

These assignments cover different aspects of the subject, developing abilities (knowledge, skills and attitudes) stated in the objectives.

Virtual Campus Atenea has been used as a tool to improve the communication between professor and student. It allows direct communication and sharing information individually and collective, without time and space limitations. Assignments are uploaded to Atenea during the semester. First and second ones are used to introduce statistical problems and techniques to be treated in the subject, and therefore uploaded during first days of the semester.

First and second assignments deal with data analysis:
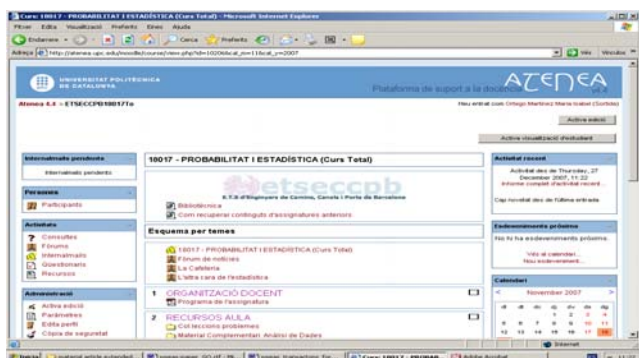*People around us* presents basic concepts of data analysis:

population, sample selection, graphical representations and information summary. A survey to collect some information about the student was carried out during the first classes. The survey consisted of 35 questions of different kind such as age or favorite tv program. Collected data were used in some of the activities. Each student had a personal file formed of 30 observations drawn at random from the obtained data set.

Other interesting data introduces students to data sources: Official Statistics Institutes as 'Instituto Nacional de Estadística' (www.ine.es), the 'Institut Català d'Estadística' (www.idescat.cat), international surveys as the European Social Survey (www.europeansocialsurvey.org), as well as basic relationship between variables (correlation, linear regression, etc.)

Third assignment deals with probability; *Let's compute illusions* introduces basic probability and random variables using a Spanish well known lottery (ONCE).

Fourth assignment, *Techniques nowadays*, deals with modern techniques, i.e. some techniques that usually fall out of program of a statistics course, but can be understood with a basic level of statistics (e.g. capture-recapture techniques). A brief historical introduction is provided as well as some applications (medicine, social sciences, engineering, etc.)

Fifth assignment, *Classical knowledge*, deals with the historical development of probability and statistical techniques. A brief introduction to the life of some important mathematicians and the techniques they developed. Some
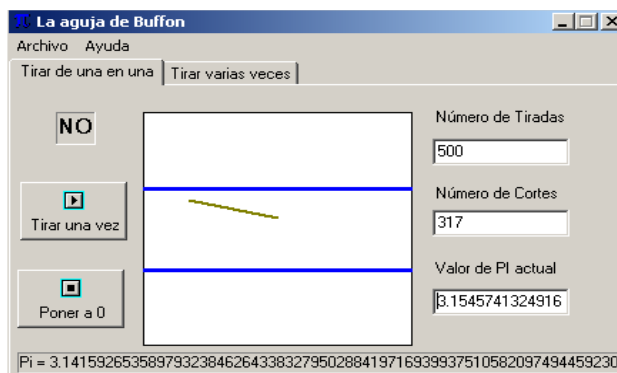

Fig. 2 Buffon's needle Applet

classical examples are introduced (the Buffon's needle, Chebyshev's inequality, etc.)

Final assignment covers all the subjects introduced at the course. Students start from an open problem: they should perform a whole statistical research, including data selection, data summary and use of statistical techniques (e.g. multiple linear regression, Anova) and inference. Writing a suitable scientific report is specially important, as well as drawing conclusions about the experiment, fostering criticism. The originality of data is specially appreciated, as well as the synthesis skills, accepting negative results of the treatment of data if they are well discussed.

V. CONCLUSION

Development of self-learning activities in Statistics has shown that main objectives have been reached successfully. The student feels he/she is participating more in the subject, so the number of motiveless students decreases. Studying real situations around them makes the subject 'useful' for the student.

Team and individual work is developed, making laboratory classes more valuable. Laboratory sessions are used to introduce statistical software, which often is not used later for the student. Self-learning work requires the use of this software, so laboratory sessions become useful. Altogether involves more implication of students in the subject, implying increased profit and motivation. Specially important is the decrease of the number of students who abandoned the subject since self-learning activities started.

Bologna process implies a whole change in teaching at university. This is only first step, very timid, we should say, but an important one to help adaptation to new paradigm, helping reluctant professors change their minds, as they see successful results of the experience.

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