Teaching and Learning Calculus using WIRIS Technology in Moodle environment

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This project focuses on the teaching and learning of mathematical topics at different engineering schools of the Universitat Politècnica de Catalunya (UPC).

The field of application of the project are the mathematics taught in the first year of university studies, with special regard to Calculus. The engineering schools involved in the project are Escola Tècnica Superior d'Enginyers de Camins, Canals i Ports de Barcelona (UPC), Facultat de Matemàtiques i Estadística (UPC) and Escola Universitària d' Enginyeria Tècnica Agrícola de Barcelona (UPC). During this year the former two are running a pilot course and the latter is about to implement a similar one.

As teachers have to ensure that technology is actually an efficient learning resource, a mean to acquire the technical attitudes and skills required to tackle a problem successfully, and not just an optional software module. Of course the use of technology redefines the teaching and learning process. Our project works in this sense.

In this course we use virtual tools aiming at the improvement of the learning process. These virtual tools use WIRIS technology integrated in Moodle (Modular Object-Oriented Dynamic Learning Environment). WIRIS is a software family of products dedicated to mathematical calculation and formulas designing mostly used as education tools for learning mathematics. Students and teachers have free access to WIRIS tools through education portals.

Moodle is a course management system, a software package designed to help educators create quality online courses and manage learner outcomes. The design and development of Moodle are based upon a particular philosophy of learning, a way of thinking that is referred to in shorthand as a "social constructionist pedagogy". Constructivism claims that people actively construct new knowledge as they interact with their environment. When the constructivist point of view is extended to a social group that collaboratively creates a small culture of shared artifacts with shared meanings, then we are talking about social constructivism.

Learners can access our course through almost any browser, including Internet Explorer, Mozilla and Firefox. The course comprises a combination of learning activities for students, such as Assignment, Chat, Choice, Forum, Glossary, Journal, Lesson, Wiki and Workshop.

WIRIS is an Internet platform which, on the one hand, performs general mathematical computations asked by its users and, on the other hand, supports the creation of Web-accessible interactive documents and materials. Basic philosophy and briefly expressed, is that in the programming of a system for doing mathematics by computer "mathematical language should be the ruler" (at least as much as possible). This is not easy, because mathematical language is quite complex, but the point behind the thought is that the syntax and semantics of mathematical expressions, including those of a logical nature, have evolved trough the centuries into a very expressive, concise, and reliable language. Hence, substantial advantages are gained by making as much of this language as intelligible as possible to a computer program.

In order to apply WIRIS technology to teaching and learning mathematics at our engineering schools we have designed and developed a first project called EVAM (Virtual Tool for Mathematics Learning), which was followed by a second project called BasicMatWeb. The main features of both projects are outlined below.

1. EVAM [http://wiris.upc.es/EVAM/]: EVAM is a virtual tool which helps reinforcing the mathematical background of students entering an engineering school, namely, basic linear algebra (matrices, determinants, systems of linear equations), trigonometry, single variable functions (basic concepts, limits and continuity, rules and techniques of differentiation, maxima and minima, Taylor expansions, basic techniques of integration) and plane geometry.

2. BasicMatWeb [http://wiris.upc.es/basicmatweb/]: The creation of BasicMatWeb can be envisaged as the continuation of the previous tool. This virtual tool aims at the teaching and self-learning of the basic mathematical topics taught during the first year of engineering studies, including, among others, linear algebra (algebraic structures, real vector spaces, linear functions), multivariable functions (geometric representations, limits and continuity, partial differentiation, maxima and minima, Taylor series), and ordinary differential equations (general properties, analytical

methods for solving some types of first-order ordinary differential equations).

Some advantages for users and for the academic community is that only a standard Web browser with Java is required on the part and on the end user. In other words, users need no complementary software. The interface and the computational engine can also be adjusted according to the specifications of the school involved. In any case, the architecture of WIRIS enhances and excellent adjustment to the computer and the communications facilities available.

Expected conclusions: The methodology we have just sketched in our project will fit perfectly in the framework of the European Credit Transfer System. As a professional engineer-to-be, this methodology aids the student gain competence in working both independently and in team, managing time effectively and using computer resources appropriately.

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