CASE STUDY: COMPLEMENTS OF MATHEMATICS AND E-LEARNING

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Abstract: In this study we present the experience of the work done during this course with students of the subject of Complements of Mathematics. We used the computer in class every day and we have proposed to students daily activities and a final paper related to any of the items on the subject. The use of eLearning platform along with other tools is an improvement in the education system. This study has been developed specifically with students from the last engineering courses and shows how Mathematics could help engineer students to change their traditional point of view related to university studies and learning tools.

1 INTRODUCTION

Computers have been infesting all areas of our daily activities, especially those related with information management. The acquisition and processing of news and information, mail and social contacts are increasing by computer use. In addition and simultaneously, the number of users that somehow left out is unable to adapt to constant technological renewal, is decreasing.

The continuous advances, unfortunately, not always supposes an improvement in the person machine interaction. At this time computers are more or less "stupid" and lacking in initiative because people is the responsible for initiating the interaction with them. This will require knowledge of the management of all the applications used. In the very near future this will change because of software agents. The emergence of these new tools will facilitate what is known as indirect or delegated administration. This will not remove the user of the ability to interact directly with the computer. However, it should always perform all processes, it may delegate certain tasks.

Teachers are, every day, adopting computers as teaching tools needed, and using them to carry out a more effective teaching and greater quality levels. The Information and Communication Technologies (ICT) are an important element in the convergence of universities to achieve a common European space of higher education (Queiruga, 2008), which represents a culture change associated with a change in university studies.

This paper describes in detail some changes related to the Complements of Mathematics subject and the new methods and tools used for obtaining the new educational system. We perform the integration of new teaching methods with traditional, using eLearning and others mathematical tools as a model of further education (Mason, 1998).

As is well known mathematics are very close, in general, with computational sciences. The area of mathematics is therefore, one of the most adapted for the incorporation of the new technologies, since it is not only one purely formative subject, but is a scientific tool for the students who must help them to solve the problems that are generally throughout their race and in its professional development.

Nowadays, the internet technologies and software agents are becoming increasingly important in online learning systems. Web-based training and the use of agents offer the opportunities to enhance traditional courses, encourage life-long learning and enable more people to join the learning society. Software agents prove to be the necessary tool in improving the effectiveness and efficiency of retrieval in such systems (Impagliazzo, 2004).

This paper is organized as follows: In section 2 we will show the Complements of Mathematics subject structure, the work and tools used by students and the works developed in classes are

detailed in Section 3, and in Section 4 the conclusions of the study are presented.

2 COMPLEMENTS OF MATHEMATICS SUBJECT

In this section we can differentiate what was the subject so far and in what has become. The teaching method we have proposed this course has changed so that students can use the computer throughout the duration of the course. We proposed at the beginning of the course the use of Mathematica package (Wolfram, 1999) for searching, analyzing and developing any of the themes of the course.

The objectives proposed in the curricula of Complements of Mathematics subject are the following:

1. Modelling common scenarios in engineering problems and applying appropriate techniques to solve the problem.
2. Using exact and approximating mathematical techniques.
3. Using appropriate tools to solve the problems.

The work plan in accordance with the existing curriculum could be considered as follows: The course is separated in lectures and problem classes, with the schedule approved by the competent bodies. Additionally, each teacher has student opening hours. Since the course only lasts 4 months (quarterly), it will not be a "classical" final exam on the scheduled date.

The final assessment consists of carrying out the proposed activities to make students understand all the contents of the subject by focusing on one in particular. All the classes are done in the computer room and the practice session consists of different problems to be solved in the Mathematica environment.

The whole theoretic contents of the course are:

- Direct methods for solving linear systems: Gauss, Cholesky and LU factorization.
- Iterative techniques in matrix algebra: Jacobi, Gauss-Seidel relaxation.
- Approximation of eigenvalues power method, deflation method, QR algorithm.
- Partial differential equations. Some methods of integration of partial differential equations.
- Review of functions of complex variables. Residue theorem. Applications of the calculus of residues.

The methodology that we used for this course is a virtual platform together with mathematical software (Díaz, 2009).

Due to its inherently distributed nature, a distributed-learning environment can be supported and managed by a set of autonomously cooperation software agents that communicate intelligently with one another. They can interact with human users at the right time, with the right information. Much experimental research has shown that intelligent software agents, such as interface agents, information agents, and collaborative agents, have great potential to reduce information workload and to automatically perform many knowledge-an labor-intensive tasks for users. For example, these agents, with the functions of motivation, learning facilitation and collaboration, and so forth, serve as students' assistants, companions, and tutor (Oscar, 2005).

3 APPLICATION OF MATHS TO REAL LIFE

An important task for engineers is to learn how it is possible to model daily events and objects with mathematical tools. It is considered that problem solving is an important part of their education; by interpreting such problems as a context within which they can apply Mathematics to aspects of the "real world", they can learn how to make practical use of their mathematical skills (Lantz-Andersson, 2008).

The School of Industrial Engineering aims to prepare students for leadership in industry and to be at the very centre of developments for addressing the economic and social needs of the country. The School has always been closely linked to the society it serves.

One of the most used tools by students to perform their tasks is the internet. Tutors are responsible to make them see the dangers of the Internet and the vast amount of data. Finding information can be a very costly task. At this point the software agents are useful because they help us unravel the information saves time and effort. The agents dealing with information use a series of filtering mechanisms based on content. Filter selects themes based on correlations between the content of the topics and references of the user.

We will show in detail some of the activities and final work that students made.

3.1 Application of Mathematics in a Garden Sprinkler

In this case the working group uses the LU factorization to explain how a sprinkler works. LU decomposition is a matrix decomposition which writes a matrix as the product of a lower triangular matrix and an upper triangular matrix. This decomposition is used in numerical analysis to solve systems of linear equations.

3.1.1 Movement of the Sprinkler

Depending on the position of the output link of four-bar mechanism, the sprinkler will water one way, on the other or both ways.

The elements of the sprinkler are:

- Turbine and worm 1 and crown wheel 1: Water affects some pressure on the blade by rotating turbine. On the turbine shaft is located a screw endlessly rotates the turbine. This screw engages with a cogwheel. The mission of this gear system is to reduce speed.
- Worm 2 and crown wheel 2: Again, another mechanism of worm and crown wheel reduces speed to reach the four-bar mechanism.
- Mechanism of four-bar linkage: The links are connected by joints that allow the rotation of a rigid body over another.

3.1.2 System of Linear Equations

The system of linear equations is obtained from dynamic analysis of four-bar mechanism. For resolution the Mathematica software is used, with the implementation of some functions to get the LU factorization, decomposing the matrix obtained with real data, in two others. This is the way to calculate the forces acting on the links.

3.2 Functions of Complex Variables

Before finalizing any design, should be checked how it reacts with airflow to achieve a perfect combination of aesthetics and performance. To perform this check, used the so-called wind tunnel, which is a compound which simulates actual air flow. The components of this device are:
- Cavity to stabilize the flow establishment.
- The reduction cone compresses the air volume increasing speed
- Test section where the model stands.
- Diffuser that reduces the wind speed.

Thinking about wind tunnel students quickly relate it to the world of motoring, and particularly with the automobile and aeronautics, but the reality is that the wind tunnel has a very broad utility, from skiers to missiles, through buildings or trains.

For general modelling the potential flow is considered, excluding something as common as the turbulence. The purpose of complex analysis is to calculate the coefficient of wind resistance, and the results of the flow lines. Due to the nature of certain flows, longitudinal sections along the flow lines can be considered for analysis. This remains then a two-dimensional system that can be analyzed mathematically using the complex plane where one element is given by a complex expression.

Because of the complex analysis requires millions of calculations, CFD (Computational Fluid Dynamics) has been developed to analyze and solve problems concerning fluid flows.

3.3 Partial Differential Equations

Any differential equation that contains partial derivatives is called partial differential equation. In any partial differential equation, the dependent variable (unknown function) should be a function of at least two independent variables since otherwise would not appear partial derivatives.

The vibrations that occur during driving, flying, travelling by train, or those produced by a machine tool during cutting, which suffer the blades of a turbine rotating at several thousand revolutions per minute or vibration that supports a building during an earthquake are usually governed by the wave equation.

A membrane attached by the edge and under uniform tension, the ideal patch of a tambourine, vibrates according to a partial differential equation. And also the heat equation, which describes how to distribute the temperature versus time and space, follows another type of partial differential equation.

3.4 QR-codes

In this issue we found the example of how the amount of information available on the Internet is not enough to find the solution to a problem. This group of students wanted to find an application of the QR decomposition, which writes a matrix as a product of an orthogonal matrix and an upper triangular matrix, and multiply the factors, and iterate, but what they found were the QR codes, a matrix code created by Denso-Wave corporation, to

allow its contents to be decoded at high speed. The meaning of "QR" is "Quick Response".

4 CONCLUSIONS

This study has presented a case study in which existing software agents are used, this is not about making a new development related to agents or similar education software, but to use what already exists. We have detailed the subject of math supplements, a subject of the second cycle of industrial engineering. In it, students must perform the proposed activities each day and make a final work at the end of the course as application to real life.

The internet is considered as supplement to traditional teaching, we have seen, by the end of the course a survey of students, that the online teaching-learning system, has allowed its use to the maximum use (Kearsley, 1998). Students and teachers can access the work and activities at any time, students have available and affordable all resources, and the means for optimum use of the subject, and the flexibility of the word wide web involves a cooperative platform, rather than independently, allowing students to interact and organize the course as needed (Aliev, 2001).

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