LEMAT: A project for innovation in teaching mathematics

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Abstract

"Lemat" is an acronym for Libro Electrónico de Matemáticas, which means Electronic Book of Mathematics. It is a project developed by a group of teachers at secondary school and university levels, with two main objectives:

- *The design, testing and implementation of new models of teaching strategies based on new technologies and focused on student learning, creating digital contents of mathematics of general interest for students in the two last years of secondary school and university students in first year of technology and sciences*
- *To create a work-group for collaboration between different education levels, opening up ways of communication, thinking and cooperation, and making it possible to translate its aims to the real world.*

Access to Lemat Project is free with an anonymous password (User: ucex0201, password: LEMAT) through the "Virtual Classroom" of Cantabria University at www.aulavirtual.unican.es.

1. Introduction

Lemat came about in 2002 as part of a project between Cantabria University and the Regional Department of Education, for Teacher Training. This collaboration between different education levels has been very important for both parts. Teachers at secondary school now know better the level and methods required for the university, and university lecturers know for themselves the real situation of mathematics at secondary school. Lemat integrates different points of view, including scientific and technical orientation in university [1].

The group works as a collaborative team [4], with the gentle direction of a manager to coordinate efforts in

- designing and carrying out the mathematical contents of each item, from both the academic and the technical points of view
- evaluating software to be used in Lemat
- practicing in classroom
- investigating the use of TIC (Technologies for Information and Communication) and e-learning in teaching mathematics and sciences
- attending and participating in meetings and congresses
- making new proposals for Lemat

Lemat is implemented in the e-learning platform WebCT (now Blackboard Learning System), supported by the University of Cantabria.

2. The e-Book: Academic and Technical Design

Some fundamental characteristics of Lemat are the following:

- The subjects (didactical units) have been created to be used as a self-learning-system by the students, without the need of the physical presence of a teacher.
- The contents are also selected and organized to be used by the teacher in the classroom (computer laboratory, or a classroom with a computer per student, if possible). In this case the teacher acts as a personal assistant, to solve students' doubts.
- Thanks to HTML language (and XML,…), Lemat can be used in a linear way, like a paper book, or can be used in a free form, navigating through the different contents, with the user creating his own route. It can be used also as a reference tool.

- We have chosen the standard MathML for mathematical expressions, thereby obtaining carefully prepared texts, and also these mathematical expressions combined with dynamic applications using JavaScript to make the "Labs" of Lemat ([6]).
- The interactivity between the user and Lemat has a fundamental role in Lemat. This interactivity is achieved using different tools: labs for calculus tools; exercises to introduce new concepts that need the student responses; comprehension exercises; dynamic applets to show and try new ideas, and practice with new concepts, self-evaluation, pre-evaluation and post-evaluation.
- Contents are presented at different depth levels, so the user has to work with Lemat to find the responses to the questions, and not just look at the monitor.

3. Communication Tools

The communication tools of the digital platform are a fundamental part of the teaching and learning process. We use the e-mail service and forum to maintain contact between a teacher and the group of students.

There is also an e-mail service and a forum for those who use Lemat independently, perhaps as a reference guide for the subject. These tools are attended by all the teachers of the Lemat group.

4. Didactic Design

When a new user goes into Lemat, he can find on the first page a complete "guide to use" of Lemat, and also a guide to check the software needed in the computer, with links to the respective programs for a correct viewing and use of Lemat.

On this first page there also appears the "Thematic Index", which leads us directly to the different contents, called "thematic modules",

Each module has some links:

- PRE: pre-evaluation tests
- 1, 2 or 3 buttons: links to the corresponding level for that module. The first level has the content for the last year in Secondary School. The second level is a bridge between Secondary School and University, thus complementing the content of the secondary which can be more important in the first year of engineering or scientific studies. The third level corresponds to first year of mathematics in any university degree.
- Info: explanations about content, structure, objectives, etc.

As shown in Figure 1, the content of Lemat is 75% completed.

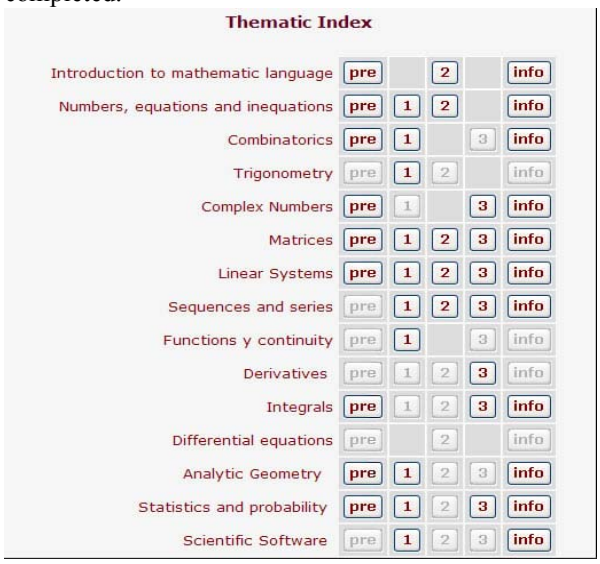

Figure 1: Thematic Index

Some modules have blank spaces, because there is not the corresponding level for that content. Light buttons are the units in which we are working now to complete the content on Lemat, and dark buttons are completed items.

module	main pages	examples	self-evaluations	exercises, problems	images/graphics/ animations	Labs, applets	auxiliary windows	total files
Intr. to Mathematical Language I	19	73	5	122	108	1	113	**441**
Numbers, equations, inequations I	8	8			18	2	4	**40**
Numbers, equations, inequations II	29	94	5	113	155	20	140	**556**
Combinatorics I	14	4		23	3	2		**46**
Trigonometry I	30	16			26	14	15	**101**
Complex Numbers III	42	53		60	43	28	93	**319**
Matrices I	30	9		13	22	11	77	**162**
Matrices II	18	44	7	28	19	62	56	**234**
Matrices III	78	95		33	2	32	29	**269**
Linear Systems I	26	22	8	6	46		33	**141**
Linear Systems II	11	19	1	5	18		33	**87**
Linear Systems III	23	7		15	6	21	20	**92**
Sequences and series I	19	19	2	87	66	209	206	**608**
Sequences and series II	63	22		38	49	19	7	**198**
Sequences and series III	342	221		236	55	11		**865**
Functions and continuity I	14	5	1		60			**80**
Derivatives III	129	94	5	35	224	16	10	**513**
Integrals III	20	10	1	11	144	3	2	**191**
Analytic Geometry I	37	11	8	28	162		99	**345**
Statistics and probability I	46	11	3	7	37	3	2	**109**
Statistics and probability III	85	72	1	13	190	28	27	**416**
Scientific Software I	17	1			25			**43**
total	**1100**	**910**	**47**	**873**	**1478**	**482**	**966**	**5856**

Table 1: Lemat in numbers

The main body of each unit is an html file which has many of links to other files with exercises, proofs, labs, etc. Some of them must be visited, others should be visited to complete the information or to have

formal proofs of some important results, and others are complementary contents for the unit.

Lemat uses JavaScript applets or labs to show new concepts in such a way that the student can "touch" them, and to make some calculus tools to be used in solving exercises and problems. The units are also full of graphics and animations.

Table 1 shows the work developed inside the Index.

5. Classroom Experiences and Results

Since 2003/04, Lemat has been tested in real classrooms, in several secondary schools and in the first year at the university (Mathematics and Physic Degrees, Industrial Engineering (Master and Bachelor), Engineering in Telecommunications) ([2], [3], [5], [7]). This comes to more than 300 hours in the classroom, plus the time spent by students independently.

This experience led to Lemat winning the "Galicia Prize for Information and Communication Technologies in Mathematical Education" in 2005.

The most important results of these trials are:

- The tested units were complete and adequate for the respective subjects
- For classroom use, it is advisable to make a "work route" to guide the students.
- The building focus for the teaching model of Lemat, growing from examples, exercises, situations, data, etc, makes the learning more significant.
- Lemat can also be used as a complementary reference and guide for rapid browsing.
- The students have found new tools and new methods to learn, complementing traditional teaching, and improving the effectiveness of the educative task.

6. Next Objectives

Contents: Although our first goal is to complete the mathematical contents of Lemat, filling all the buttons in the "Thematic Index", one of the most valued characteristics of an e-learning material like Lemat, based on new technologies, is the possibility of a constant evolution, adapting and adding new contents, models or techniques. It is obvious that, in contrast to a paper book, Lemat has no end, and its objective is continual growth and improvement.

Technical aspects: The structure of Lemat inside WebCT must be adapted to take advantage of all the capabilities of the learning platform. The original design of Lemat was made for a primitive and elementary version of the virtual platform, and now it is necessary to modify it to make better use of Blackboard L.S, also adopting some standards to make it easy to move on to new versions, or even another learning platform.

It is necessary to investigate the possibilities of adapting Lemat to other operating systems like Linux, widely used by potential users of Lemat.

In the future, we plan to incorporate into Lemat new tools for students with special physical difficulties that could be overcome with new technologies, such as special formats of video or audio.

Improving the use in classrooms: An information campaign to promote the use of Lemat in secondary schools and in the university is necessary.

Improving the autonomous use: We aim to offer Lemat as a complete system for self-learning. To this end, we need to implement Lemat in an autonomous physical support such as a CD.

7. References

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[8] "Libro Electrónico de Matemáticas: análisis del proyecto para el aprendizaje autónomo de las matemáticas" IV JORNADAS DE REDES DE INVESTIGACIÓN EN DOCENCIA UNIVER-SITARIA. Universidad de Alicante (2006) ISBN 84-690-931-1