# AN INTERACTIVE E-BOOK APPLIED TO MATHEMATICAL LEARNING[1]

Francesc Vallverdu, Teresa Sancho[2]

## ABSTRACT

This work will discuss on a course material in web-format for teaching and learning Discrete Mathematics, a subject that is offered at the Computer Science School of the *Universitat Oberta de Catalunya (UOC)*. This university is an open one, where any communication between teachers and students is via e_mail.

For UOC students the classical textbook is no longer useful, so we propose a digital and navigable didactic material that integrates the basic elements of the self-learning process. Also, it contains self-evaluation exercises, computer animation, audio, conceptual maps and glossaries. Obviously, this material will include any kind of typical navigator functionality too.

The learning and teaching process is evolving with the new information technologies. The teacher-student relationship is changing, even more in distance education. The interactivity between the student and the material can be done through the resolution of exercises and the experimentation with simulated cases. The simple exercises are usually Java Applets embedded in the same html page where the exercise evolves, in a xml framework. Depending on the student's behavior and skills, different paths are presented in order to optimize the learning process. The more the student knows, the more difficult questions are. A tailor-made and oriented evolution implies an intelligent tracking of the student's actions. In this respect, we might say that this kind of activity allows either the student to learn significantly or the teacher to keep the process under control.

## DIGITAL BOOKS FOR DISTANCE LEARNING

The UOC student profile is not usually the same one as in a traditional university. UOC is an open university with a virtual campus (http://www.uoc.es) where both students and teachers interact, breaking time and distance constraints. Most students are aged between 25 and 35 years old, they are mostly married with children, have not studied for a long time and, last but not least, have a regular job. Hence, they are usually highly motivated and responsible students.

With regard to technical studies, the learning process of mathematics has some particular characteristics: a mathematical course requires a minimum basic formation, but hardly ever meet the student's particular interests. The student is demanded to make an initial effort to acquire previous knowledge, to develop mathematics skill and, finally, to attain abstraction. For these reasons, the didactic material, so fundamental in this context, should consider different factors: previous knowledge, interests, objectives, capabilities and practical constraints.

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[1] This work has been developed within the IBM/"la Caixa"/UOC 1998 agreement.

[2] Universitat Oberta de Catalunya. Computer Science School. Av. Tibidabo 39, 08035 Barcelona, Spain
e_mail: fvallverdub@campus.uoc.es, tsancho@campus.uoc.es

Nowadays there is a general trend to use electronic books instead of traditional paper ones. They have many advantages (hyperlinks, fast find, and link to other material or web page, etc.), even though our students still prefer to have paper books. The main problems exposed by the end users are related with a lack of a real added value. They consider that hyperlink and search facilities are not enough to prefer this kind of material. On top of these general aspects, it is important to stress on some practical considerations: initial rejection by the students, a visual fatigue caused by the computer screen and the impossibility to have a mobile workplace. To sum up, dependence on computers implies physical uneasiness in most cases.

The teacher-student relationship is changing, even more in distance education. Newborn tools allow tailor-made individual training. Here we present a contribution concerning the evolution of a textbook towards a digital one. We define a learning environment that includes the basic material and a virtual bookcase with library books, FAQ, complementary notes, interest links, complementary exercises and glossaries. This environment provides orientation to the student by guiding him through the learning process.

Here it is presented an interactive learning material prototype. Coming from a navigable book [2], nowadays used in the Discrete Mathematics course [1], some new features have been implemented. The main ones are: interactive simulation space, text to speech conversion of the selected text (including mathematical notation), insertion in any point of a page of personnel notes, marks or text underlying, open question possibility, dynamic page generation (depending on user activity), automatic evolution report generation and assessment.

## AN EXEMPLE: THE CHICAGO'S PROBLEM

In order to show some of these interactive features we present the implementation of Chicago's problem (mismatching problem), a typical combinatory one.

The basis of this problem consists of counting the number of mismatching couples selected out from a pair of sets. In this particular exercise, we are playing with letters and their corresponding envelopes. The first time you get the problem it is only shown a general statement and a simulation space, as shown in fig. 1.

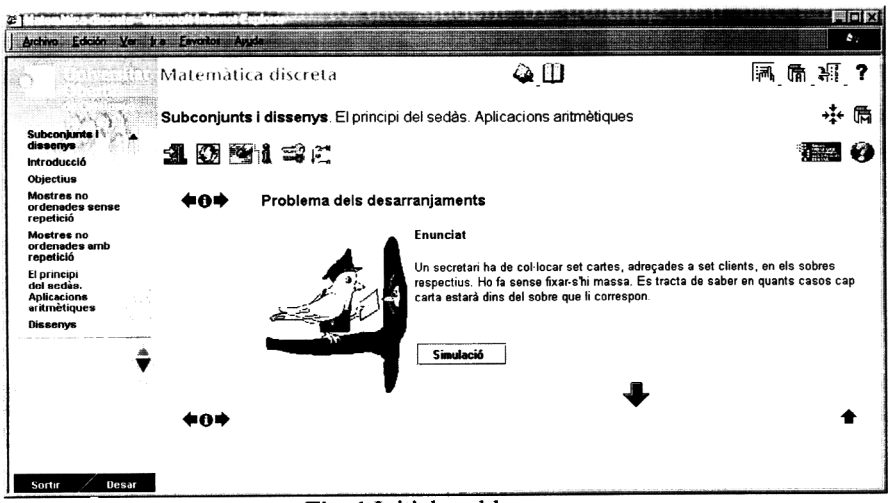


**Fig. 1** Initial problem page

The simulation space is an interactive tool that makes it possible to experiment and play so, understand and get insight the problem. The user can select the number of couples. The coupling procedure can be made either by hand ('drag and drop') or automatically with a random function, one by one or altogether. The coupling result is also displayed, marked with a cross if a mismatch occurs, otherwise a *v*. Fig. 2 shows the implementation of Chicago's problem simulation. It is also possible to select the number of iterations of this experiment, hence, to treat some probabilistic results through the frequency representation of different events. In this example, a graphic of absolute frequency couple matching is displayed, after the achievement of 200 experiments.

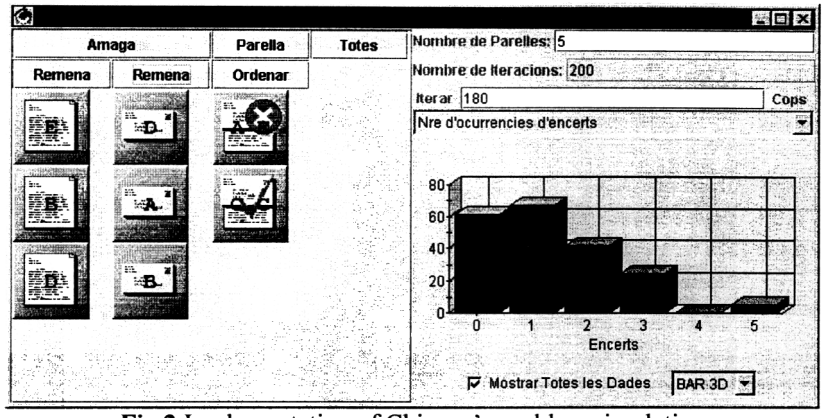


**Fig.2** Implementation of Chicago's problem simulation

Once you decide to continue the page evolves introducing a mathematical statement and a question is posed. You have to write a numerical answer, and depending if it is correct or not, the page will progress in one way or another. The page evolution depends on a previously strategy defined by the teacher. Different strategies should be defined to match different student skills.

## PRACTICAL CONSIDERATIONS

There are two practical considerations to be pointed out. The first one is related to mathematical notation and how mathematical formulas are pronounced. We write mathematical formulas in Latex using Techexplorer, an IBM plug-in, and we have implemented a Java applet that controls a text to speech system, developed at the UPC (http://gps-tsc.upc.es/veu) that converts Latex to speech, in catalan language.

The second one is related to personnel annotations. A Java applet makes it possible to mark a selected text, to underline it or to include personnel notes in any point of the page. Thus it is possible to build a personal version of the digital book.

Learning mathematics in a distance education system requires specific interactive and multimedia material. This work is an example of such a material using Internet based technology.

## REFERENCES

[1] Mayor, G. et al; Matemàtica Discreta, formato electrónico. Universitat Oberta de Catalunya, 1998

[2] Vallverdu F., Sancho, T.; Agentes Inteligentes y Libros Digitales, VII Congreso Universitario de Innovación Educativa en la Enseñanzas Técnicas, Huelva (Spain) *1999*.