Using Internet as a self-learning support : an application to open-channel hydraulics

D. Bousmar
Civil Engineering Dept., Université catholique de Louvain, Louvain-la-Neuve, Belgium

F. Docq
Institute for Higher Education and Multimedia (IPM), Université catholique de Louvain, Louvain-la-Neuve, Belgium

L. Gilson, C. Manfroid and Y. Zech
Civil Engineering Dept., Université catholique de Louvain, Louvain-la-Neuve, Belgium

ABSTRACT: An interactive open-channel hydraulics course on the Internet is presented. This course, currently under development, is designed to be used for self-learning in an open and distance learning context. The purpose of this experimentation is to explore new ways of teaching, taking benefit of the interactive and multimedia capabilities of the Internet. However, the developers are aware of some limitation, among all, the student's feeling of insecurity when studying in a self-learning context. A first phase of evaluation in real conditions is reported.

1 INTRODUCTION

Recent developments of the Internet lead to a wider use of this media for educational purpose. Indeed, thanks to its flexibility, its multimedia and communicational qualities, the Internet improves the possibility of "open learning" and "distance education". Open learning is defined as an educational policy that aims to give the opportunity to learn in a flexible way : at your own time, at the place of your choice, at your own rhythm, making the course open to all who wishes to take them; while distance education makes possible a student who is unable to be at a particular place follows a lecture in a flexible way (Collis, 1996; Bates, 1995).

This paper reports an example of such an educational use of the Internet with the current development of a Web course on steady flow in open-channel at the Civil Engineering Department of the Université catholique de Louvain, Belgium. This development is supported by the Institute for Higher Education and Multimedia (IPM) of the same university.

This course is designed to be used by a self-learning student, either at university (open learning), or outside of it (distance education). Therefore, a specific pedagogical approach is developed, giving a particular attention to this student learning alone in front of his computer.

A first evaluation phase has recently been completed on a part of the course. Students' comments that will be discussed hereafter are encouraging but also challenging for the developer as they point out the need for further improvement and pedagogical innovation.

2 SPECIFIC PEDAGOGICAL APPROACH

The Internet offers many interactive and multimedia tools enabling the building of attractive learning support, including steady and animated pictures. Nevertheless, this capability is not enough to ensure an efficient educational tool.

The developer should always keep in mind the fact that he is teaching an isolated student.

In a distance education context, this distance is obvious. But this distance also exists when the Web course is used as part of an open-learning scheme : indeed, the student is alone in front of the computer and can not refer directly to his teacher or to his peers when he does not understand a part of the course or, simply, if he feels not progressing.

The student's insecurity resulting from this isolation has to be mitigated through both appropriate communication tools and adequate construction of the course. In the present development, communication tools have not yet been implemented, as the current test phase only deals with open learning in such a way that physical meetings between teacher and students are still possible in this first stage. On the other hand, a special attention is devoted to the design of the course contents (Bousmar et al., 1999).

The design of the present course tries to suit the natural learning process, regarding five conditions of deep learning proposed by Lebrun (1999). First, the learning device has to *motivate* the student : he has to be challenged, for example, by practical problems to solve. The second condition refers to *sources of knowledge*, which have to be available and relevant according to the challenging problems. The student must have a stage of analyzing and *abstracting* his new knowledge (theoretical stage) and then a stage of active *production* : the student uses the new knowledge to solve practical problems. Last condition is the consolidation of the knowledge, by *interacting* with other people or facing new situations.

Regarding these five conditions, the present device first proposes a clear presentation of the scope and objectives of each lesson, that provides guidelines for the student through his learning and help him to motivate himself. Then, using the Internet multimedia capabilities, each concept is (will be) presented in different ways (texts, figures, pictures and animation, numerical applications, etc.). In those information and analysis steps, the student has thus several opportunities to understand and assimilate each concept, but also to check his comprehension against alternative presentations.

Numerous exercises are proposed, with on-line feedback and help, to give the student the opportunity to assimilate the new knowledge by an active personal production, but also to provide him self-evaluation opportunities. Various kinds of exercises are developed : theoretical quiz, numerical application, together with a third type in which the student has to identify the solving steps for a given problem, without explicit calculation. These exercises are described in part 4 of this paper.

Last but not least, a "friendly" style is adopted in the design of the course, with some humor in the presentation by use of a mascot droplet that makes it less formal.

All the features resulting from this pedagogical approach are making this course innovative when compared with some existing multimedia materials in fluid mechanics. For example, the interactive text of Liggett and Caughey (1998) covers a wider area but is more a dynamic textbook than a learning device as it does not include exercises and self-evaluation opportunities. The present course is more similar to the computer-aided learning device developed by the Calware project (Davis, 1994). Nevertheless, when completed, the new course will include more exercises and illustrations. Also the theory presentation is intended to be less sequential and more intuitive.

3 COURSE DESCRIPTION

The topic selected for the Internet course under development at the Université catholique de Louvain is the steady flow in open-channel. This is a part of the basic course in hydraulics for the bachelor degree in civil engineering and it constitutes a pre-requisite for river engineering and for irrigation learning. Having a large potential audience, this topic was also interesting from a technical point of view as it is quite short (around 20 hours of teaching and tutorials in the existing traditional lecture) and does not require long mathematical developments that are still difficult to edit in HTML format. Lastly, the concepts to be taught are complex enough and require skill development by the student (e.g. for dealing with the selection of upstream and downstream boundary conditions), so that a valuable test of the Web teaching will be possible.

The existing lecture notes were first synthesized and translated in HTML format (mainly in French, up to now), with the addition of some interactive Java applets (Muyldermans, 1997; Bousmar et al., 1998). Then further applications, theoretical quizzes and exercises were included, together with a revision of the presentation of objectives in the lessons (Gilson and Manfroid, 1999; Bousmar et al. 1999). A first testing phase has been carried out in March 1999 by replacing one of the lessons commonly given to the students by its Web equivalent (see below).

The course is divided in 21 lessons. The duration of each of them should vary from 1 to 3 hours, depending on the lesson topic and on the student skills, so that a learning unit can be easily studied in one work session. Each lesson includes a short presentation of the objectives, a theoretical summary of the subject (with all the important formulae), a reference to the lecture notes (that will be available for downloading in Acrobat PDF format) and to classical text books, several illustrations and applications, theoretical questions and exercises, according to the lesson topic. The course is completed by a glossary of terms and equations, and by synthesis exercises. A discussion forum and a frequently asked questions list will be added later but are not yet required as the public during the testing phase are the students of the UCL who can refer directly to their lecturers.

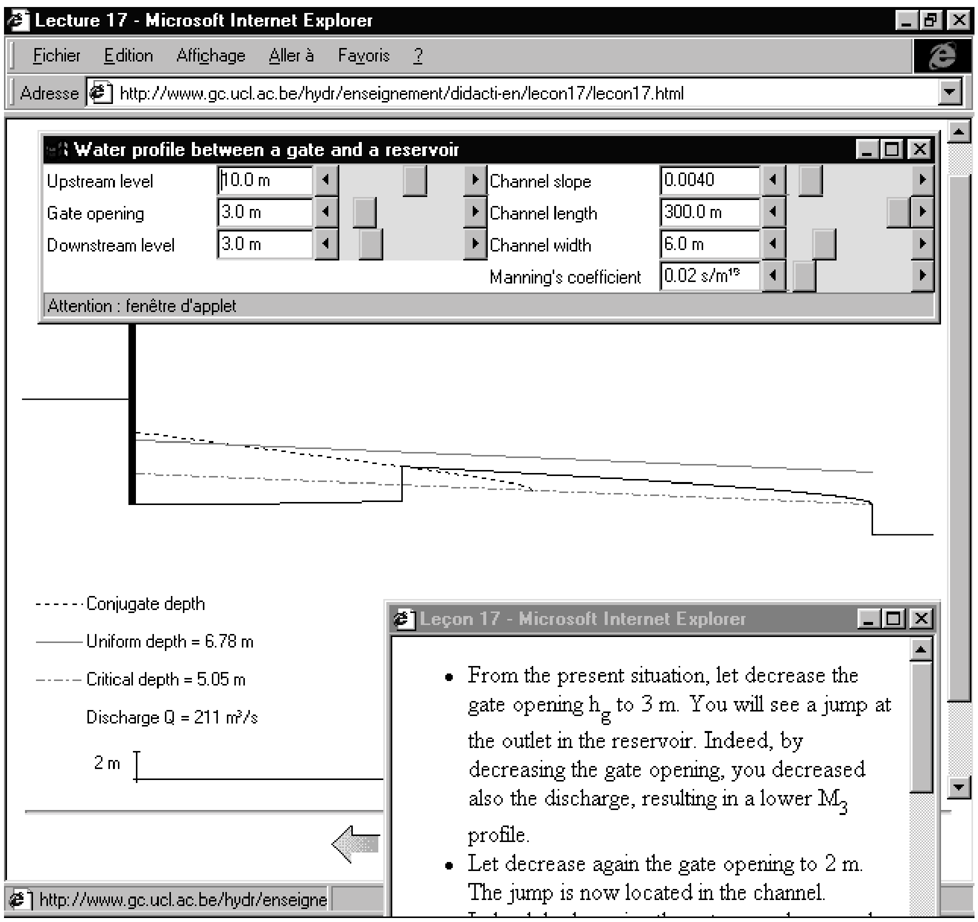

Figure 1: Java applet for the computing of the water profile between a gate and a reservoir.

4 SOME COURSE COMPONENTS

In this section, several components of the course are presented in order to illustrate the concepts developed above. All are part of lesson 17 of the course, describing the classical problem of the flow between an underflow gate and a reservoir with imposed water level.

Each lesson contains basically a theoretical summary. This summary embodies the main formulae, figures and tables of the lesson, together with some short comments. The purpose is not to use this summary as a studying support : downloadable lecture notes will be available for that purpose. This summary is more a quick reference for the on-line helps of the exercises and for the glossary through adequate hypertext links. An example of such a summary has already been described elsewhere (Bousmar et al., 1998).

Various illustrations are also proposed in this lesson. One of them is a numerical simulation tool written as Java applet (Figure 1). The user can change all the parameters values using a dialogue box and the applet instantaneously redraws the water profile. The student can thus use such a simulation as a numerical laboratory to visualize the phenomena and feel the parameters influence on the flow, improving so his comprehension. Some instructions are proposed in order to guide the student through most of the relevant situations. This applet will also be used at several places as an illustration of a particular exercise solution.

Another kind of illustration is an example of numerical solution for a typical problem (Figure 2). In this example, the solution steps are presented, together with reference to the appropriate equations. The user is also invited to fill up blank spaces with some computation results in order to keep him active and not only reading.

The theoretical quiz offers the student an opportunity for a self-evaluation of his understanding and memorization of the theoretical background. About ten questions are proposed in each lesson with multiple-choice solutions (Figure 3). A help button gives some insight of the solution or a link back to the theoretical summary. A score button is also available to get a synthetic evaluation of the results. The questions are proposed with an increasing difficulty level, ranging from the simple restitution of the knowledge to more elaborate reasoning.

Classical numerical exercises are of course proposed, with on-line help, solution check and visualization through the Java applet. More unusual are the exercises centered on the understanding of the solution procedure that the student is invited to do prior to the numerical exercises. In these exercises (Figure 4), several possible solution steps are proposed for the given problem and the user has to rank them in the right order. Each time a correct step is identified, the figure is automatically redrawn with the corresponding step of the solution so that the student gets the qualitative result and does not need to compute it. Solving those exercises, the student can develop his comprehension and his experience through a larger amount of problems without tedious computations. So he is able to pay attention to the fundamental principles.

5 FIRST EVALUATION OF THE COURSE

A first test phase was carried out in March 1999. This test involved only the lesson 17 described above (flow between a gate and a reservoir) that was already completed at this time. This lesson was relevant, since it includes representative instances of most of the components (Java applets, many exercises, etc.) and was thus suitable to test all of them.

For this test, 25 students had to study the lesson on the Internet instead of receiving it in the traditional classroom. The evaluation then concerned both their understanding of the lesson, through a short exercise resolution, and their perception of the Web course, through a questionnaire.

Unfortunately several reserves have to be expressed prior to any interpretation of the results. The test took place during a period of heavy work load for the students so that they did not spend time enough on the course and did not assimilate the pre-requisites to the concerned lesson. This kind of misapplication due to “I can do it later” problems seemed also to be faced in other experiences with self-learning courses (Davis, 1996). Another problem was that the computer rooms were quite busy and noisy, leading to some difficulty to learn in optimal condition.

Last but not least, to the question “do you attend regularly the classes”, most of the students who effectively filled the evaluation

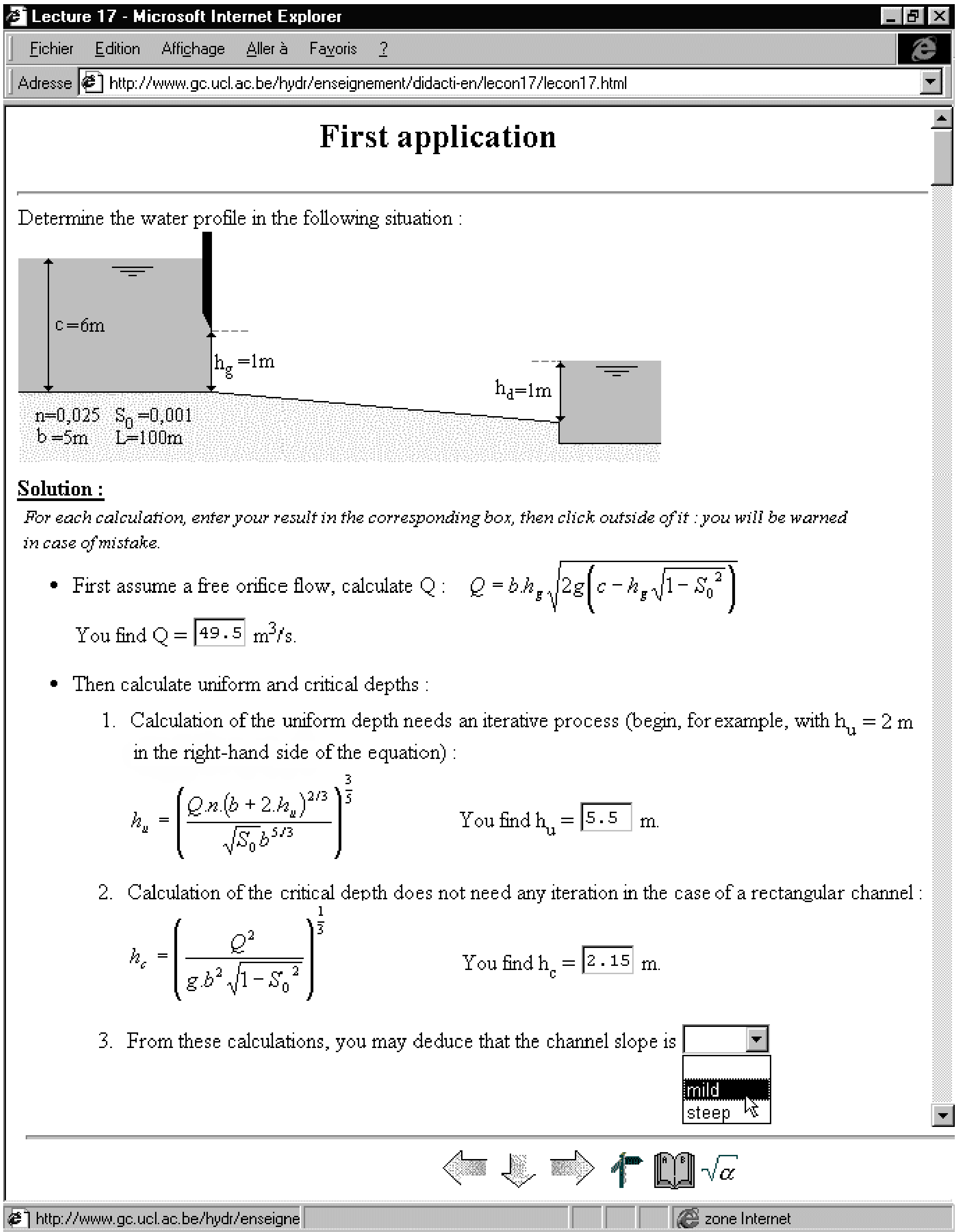

Figure 2: Numerical solution of a typical problem.

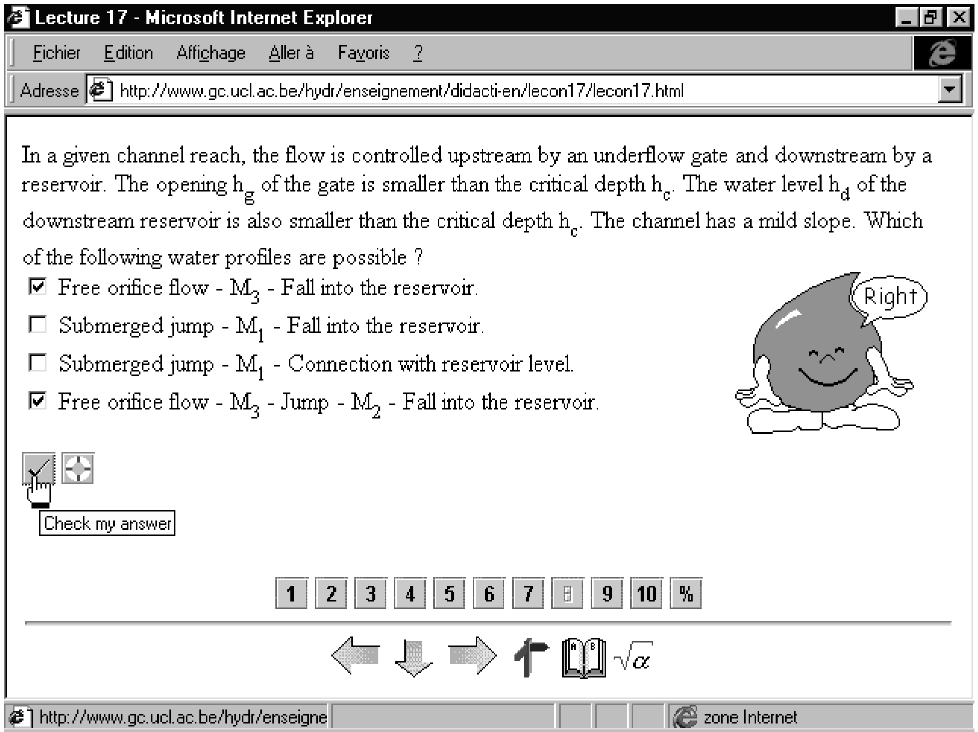

Figure 3: Theoretical interactive question.

questionnaires (one half of the class) answered yes. This could bias the interpretation of the clear preference expressed for the direct contact with the teacher. Indeed, it is supposed that students who do not attend lessons regularly could prefer to work by themselves in a self-learning way, more than students who like listening to lecturers.

Nevertheless, the students reactions about the course in itself are quite positive. They spend between 1.5 and 4 hours on the Internet, with a mean time of 2 hours. They appreciated the course presentation, but also the variety of exercises and illustrations. They explored almost all the illustrations proposed. They used most of the theoretical quizzes but only a part of the numerical exercises. The on-line help was used by half the students and was found appropriate.

The short exercise proposed to the students led to mitigate results. All the students started the resolution in the right way, but only one from 12 achieved a right answer. The new material from this lesson seemed thus understood but the numerical computation of the final answer failed : this is probably due to the bad assimilation of the water profile computation which was taught previously in the traditional way but not yet assimilated by the students. This explanation results clearly from the students' comments in the questionnaire.

Another remark was made by most of the users : it was difficult to "study" in the theoretical summary. This pointed out a failure in the developed tool. It was expected that the student would discover the topic using the printed lecture notes and, then, assimilate and practice it using the illustrations and the exercises, since the theoretical summary on the Web site was just designed as an abstract reminding the main formulas and concepts. This shows that information sources should be more developed in the course. Several analysis opportunities are given by the illustrations (numerical simulations and examples) but no appropriate source is provided in the Web for a first discovering of the material.

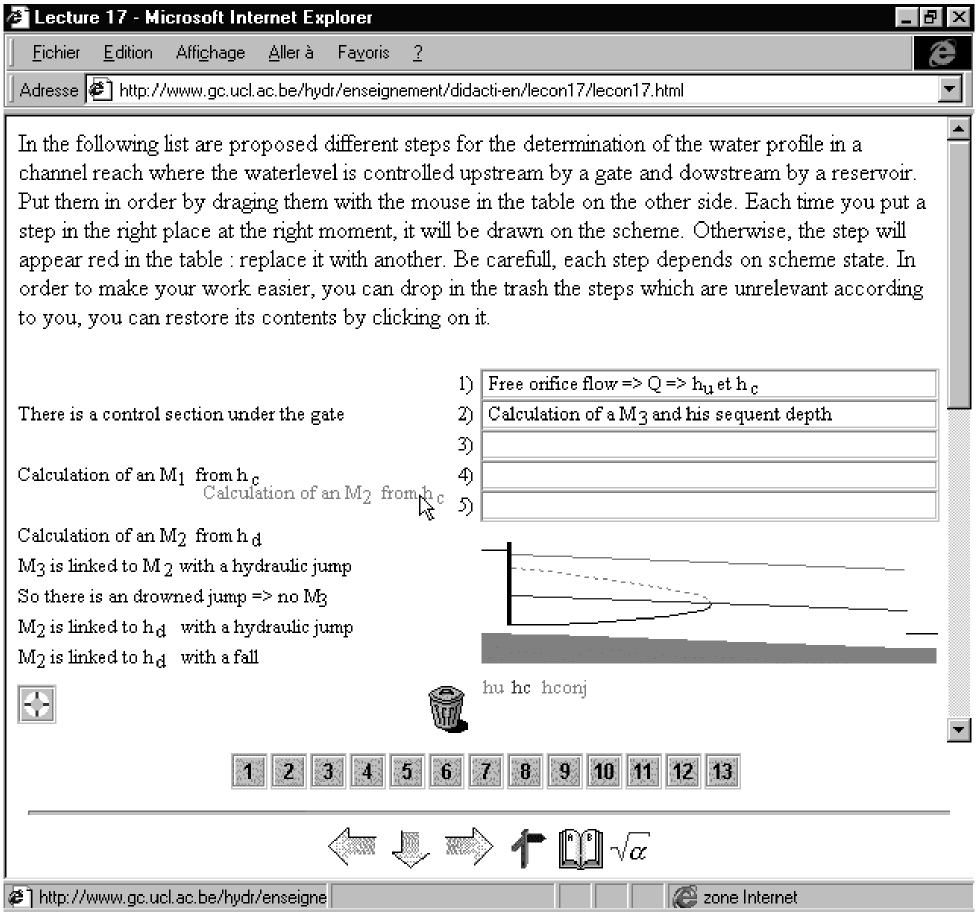

Figure 4: Exercise on the identification of the solution steps.

6 PERSPECTIVES

This first evaluation is encouraging. The approach used in developing this tool has been appreciated by the students and has proved to be quite efficient.

Nevertheless, further work is needed in order to complete all the lessons, to add pictures and movies, but also to improve several points. The objectives in each lesson should be more precise to guide the student in his learning : the pre-requisite could be quantified in terms of minimum score for previous lessons exercises; the essentials in each lesson should be specified so that the student can go quicker through it if he feels comfortable with the topic.

A first presentation of the material in each topic should also be provided in a more intuitive way than only through a theoretical summary. One manner could be to provide the student a virtual laboratory using the existing Java applets and to arouse his curiosity and his motivation with a set of questions like “what are the different situations you may observe by changing this parameter ?”. This approach, more intuitive and concrete, could also create a better learning challenge (see part 2).

A more complete evaluation of the course is also needed, when it will be finished. This will be done by dividing the class in two parts : one using the Web course, the other one receiving traditional lectures. Comparison between students’ results will then be possible, for this particular course, but also in the frame of further application courses they could attend in the following years.

7 CONCLUSIONS

The interactive Web course on open-channel hydraulics is currently under development. It is intended to be used as a self-learning tool and, therefore, a specific pedagogical approach has been developed. First observations of its use by student are promising but also challenging since need of further improvements clearly appeared.

This experiment shows that, while the Internet offers many possibilities to disseminate knowledge and improve the existing teaching, a particular attention has to be devoted to the pedagogical design of the proposed tools. Even if he has then less formal contact with his student, the teacher's job in such a learning experiment is still of first importance. Indeed, more technical and pedagogical skills are probably required to write such a course than to give a traditional lecture.

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The described course is currently available free of charge at the URL :

http://www.gc.ucl.ac.be/hydr/enseignement/didacti/home.html *(in French)*.

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