Design and use of a hypermedia system at the University level

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Abstract

The present communication reports on an experiment in which a whole semester course was replaced by a mixed formula consisting in a CD-ROM completed by a series of seminars and hands-on workshops.

The CD-ROM designed for this purpose uses Netscape as a way to browse through a set of texts, research data, references, videos and activities. A genuine pedagogical concept has been added to this hypermedia urging the students to collect relevant information in order to answer general questions presented as challenges. Three different guidance modalities can be chosen, ranging from small to important assistance. Moreover, a multiple-choice questionnaire accompanies each challenge designed both to foster self-evaluation and to give direct access to insufficiently studied portions of the material.

Careful analysis of the exams taken at the end of the year and of students' answers to an anonymous survey on the whole experiment showed that such a formula had significant effects on the learning of the material and was generally favourably accepted by a large majority of students.

Keywords

Integration of hypermedia in educational practices or formation, design of hypermedia documents at didactic ends, pedagogical use of hypermedia systems, evaluation of hypermedia environments, cognitive and pedagogical aspects

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1. New technologies and university

Universities must manage an increasing number of students. In Switzerland for example, the Swiss Council of Science anticipates a 20% increase in the number of students in the coming years. Seminars become courses, lecture rooms are overflowed, and personal work is gradually replaced by simple knowledge examinations. Student's guidance becomes increasingly more difficult to provide since the size of the teaching staff, due to limited available resources, does not follow the same inflation. In addition, more and more students are forced or choose to work beside their studies and cannot attend the courses regularly.

New communication and information technologies (NCIT) might well be an answer to this situation. Multimedia systems allow indeed to release students and professors from space and time constraints while offering new formation contexts (Rouet *et al*, 1996). They also bring higher flexibility into a school organisation, making it able to adapt its teaching to broader categories of students. However, these technologies should not be used without other form of pedagogical concerns (Perriault, 1996).

According to these remarks, during the academic year 1996-1997, the Centre NTE[1] (New Technologies and Teaching) of the University of Fribourg implemented an experimental course consisting of a mixed formula involving a CD-ROM completed by a series of seminars and hands-on workshops. This course is on adolescent development

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[1] The NTE web address is: http://www.unifr.ch/NTE

and is attended by approximately 150 students, not only in psychology, in general or specialised pedagogy, and in education science, but also by future social worker and all the future teachers of secondary education, whatever the subject they prepare to teach.

The structure of this article is the following. The next section explains the choice of a CD-ROM for the course content. Section 3 describes the system set up for this experimental course. Section 4 details the teaching concepts adopted for the organisation of the CD-ROM and the development of the course content. Finally, the last section presents some observations made during this experiment.

2. Why a CD-ROM?

The choice of the medium depends largely on the kind and the sum of information that one wants to present. The course "adolescent psychology" includes seven chapters from physical, intellectual and social development to psychological disorders (stress, depression and suicide, adaptation disorders and food behavioural problems), and to behavioural problems (violence, minor delinquent). The texts of these chapters are enriched by various additional elements such as texts of authors, bills, conventions, diagnosis, biographies, references, presentation of techniques and video sequences. These elements supplement, illustrate or specify some concept, technique or theory, and allow students to deepen the course their own way (Knitting, 1995). Moreover, a table of contents, a table of additional documents and an index allow students to traverse the course according to their interests. In the same way, activities regularly punctuate the reading and allow students to implement concepts and theories. The CD-ROM thus contains many texts, graphs, tables and images, that can be seen either as course content or supplement to the course, and video sequences illustrating for instance particular problems of adolescence.

To distribute such a quantity of information, the choice of the medium was thus limited to the two following options: the University intranet or a CD-ROM.

In order to offer students the best possible working conditions and despite its known drawbacks (for instance, keeping it up to date), the CD-ROM clearly proved to be the best tool, and this for several reasons. First of all, in contrary to North America where close to 60% of university students have a private connection to the internet allowing them to reach, among other, information on their university servers (Bates, 1997), the number of students having such connections was, and still is, comparatively lower in Switzerland. Second, within our university, the number of connections was not sufficient. Thirdly, the video sequences quality would have been too dependent on the load of the local network. Furthermore, these video sequences would have probably overloaded our intranet. Lastly, the questionnaire we addressed students at the beginning of the academic year showed that approximately 40% of them had access to a computer with a CD-ROM reader. This relatively high percentage allowed us to consider that a significant number of students would benefit from a physical support such as a CD-ROM, allowing them to work at home, and increasing in the same time the availability of the room dedicated to this course.

3. The system

Up to the time of the experiment, the "adolescent psychology" course was proposed in a traditional way, with two weekly hours of ex-cathedra teaching, without seminars. In order to release students from time and place constraints, and in order to propose a more productive and more specific teaching, we chose to give up with traditional lecture and to replace it by a mixed formula, made up of a CD-ROM and optional deepening seminars.

Thanks to the CD-ROM, the course rate is no more fixed, and students can work whenever they want and where they prefer, be it at home or on campus, where time in a computer room has been allocated for students working on this specific topic. It should be noted however that students are not alone facing both new course content and new technology. The communication is far from being neglected and various helps were implemented:

- At fixed hours, an assistant was present in the "Multimedia" room for direct and immediate help. Students who work on campus could thus have direct and personalised responses to the problems they could face.

- If they preferred, students could also announce a problem or ask a question to the professor or one of the assistants by means of an electronic mailbox. Almost each question got an answer in the week, and the professor included frequently asked questions within the seminar.

- A series of web pages on the Centre NTE web site informed students about the most recent upgrades, modifications of the CD-ROM and answers given by the staff to the most frequently asked questions (FAQ).

- Finally, since the professor did not have to directly transfer the course content to the students, the time thus released was used to propose optional deepening seminars. During these seminars, each theme proposed in the CD-ROM was in turn examined, discussed and illustrated. Exploration or workshops activities were also set up. They gave the participants a much more relevant and productive approach than the standard traditional course. For instance, future psychologists could train themselves to detect mental health and body image problems among adolescents, then learn different intervention techniques, whereas future teachers worked out some

prevention modules in terms of physical and mental health, modules that they could thereafter use in their everyday work.

Sometimes, specialists on a particular aspect of a problem were invited to present their activity and to answer students questions.

The proposed solution not only transforms a traditional lecture intended for near 200 students to a series of seminar for 25 to 40 participants, but in addition, those seminars can also be adapted to the specifics of each study program and thus satisfy at best each category of students.

4. Pedagogical concepts

The CD-ROM on "adolescent psychology" is more than a simple database or a compilation of texts on the adolescent. The authors associated with the course content a complete pedagogical concept suitable to support individual student learning. This concept includes a hypertext-hypermedia set of links to navigate in the course content, a problem solving approach, a flexible help and a series of general knowledge tests.

4.1 Hypertext - hypermedia

Many research have shown that in many situations, the human thought proceed by association of ideas; a particular information awakes other ideas that in turn can call other elements of the thought. The connectionist models (Collins and Loftus, 1975) (Anderson and Rosenfeld, 1988) represent these mechanisms of the thought. Paradoxically, since the invention of printing, it is a sequential physical structure - the book - that is used as a knowledge transmission mechanism. Authors, and teachers alike, are thus obliged to transform a series of associative knowledge into purely linear information. In 1939 (Bush, 1945) proposed a system which preserves the associative

structure of information. Since then, several implementations of this concept were tested (Xanadu (Nelson, 1965), Intermedia (Meyrowitz, 1986) (Yankelovich *et al*, 1988), Notecards (Halasz, 1988) and Hypercard (Goodman, 1987)). But it is the advent of the World Wide Web (Berners-Lee *et al*, 1994) which widely diffused the concept of hypertext.

It is this concept that we chose for this experimental course. In order to offer a simple and user-friendly interface, understandable even for students having only little or no knowledge in the handling of hypertexts, we chose to use Netscape. In addition to the simplicity of its interface, this software has the following advantages:

- the course is composed by large quantities of text and various multimedia content; Netscape has been developed from the very beginning to display texts but also images and video sequences;
- this tool allows us to distribute the course content on several platforms since Netscape functions as well on Macintosh as on PC;
- the cost factor is also of importance. In an academic environment, Netscape can be used free of charge. Moreover, any ordinary text editor can produce HTML code;
- finally, in a more or less close future, we wanted to be able to consider the diffusion of the course on the web. To write it in HTML will facilitate this move.

Students are thus facing a single software to manage the various tasks proposed in the CD-ROM such as text reading, link selection, video sequences analysis (*QuickTime*) and activities (implemented with *Authorware* or *Javascript*).

4.2 Structuring the hypermedia

In order to avoid the confusion problems consecutive to the high number of links which can be proposed in a hypertext system - the famous ' lost in hyperspace problem' (Conklin, 1987), the following techniques have been adopted:

- Writing a traditional book forces authors to organise and structure their thoughts. In spite of the theoretical complete independence that governs the creation of the links, the design of a hypertext does not authorise the creation of "spaghettis dishes" (Van Dam, 1988). Therefore, the authors of the hypertext made a significant preliminary effort to structure the content.

- Transverse links are often source of distraction, in particular because students can thus easily stray away from the selected challenge. Therefore, even if links would have been a good solution for the presentation of particular concepts, we have preferred to leave this initiative to students and not to propose links between the different constitutive chapters, students using the table of contents to reach such or such chapter. Thus, the links they make become the product of their mental activity.

- The workspace (in fact the window) has a stable and similar structure whatever the selected challenge. This window is thus cut out in 3 parts called frames. The upper frame, called menu, presents the various guidance and navigation methods of the system. The left frame contains the navigation tools, with an index or a table of contents. The right frame presents the material to be studied. This material is articulated around texts, video sequences, activities and hyperlinks of different kinds (towards the glossary, the bibliography, the extensions, and so on). This frame arrangement allows students to always face a known situation. In addition, the use of frames allows students to navigate from a new document to the preceding document - thanks to the 'back in frame' command, without modifying their work context, since

the two other frames are not affected by the command (i.e., the menu and the navigation frames remain unchanged).

- Finally, a whole set of presentation conventions (filling colours, characters use for example) allow students to easily recognise the kind of information provided (essential information, exams material, illustrative information, additional documents, and so on).

4.3 Problem solving

A CD-ROM gives much more information than an oral presentation or even a book. Not to be lost in such an amount of data constitutes one of the crucial problems that arises to the users of such systems. But, as it has been shown by the cognitivists, making choices, being oriented in a universe with multiple paths, is much more easier when the search is directed by a goal to reach (Newell and Simon, 1972; Glaser, 1984). Therefore, when users start our system, they face five challenges that they will successively have to answer. These challenges, articulated around very general sets of themes, stimulate the user to browse the various chapters to find particular information on such or such subject. Users must thus traverse the various chapters and select the segments that seem to answer the theme question. For instance, the question "Which are the principal stress factors for the mental health of the adolescents and what can be the consequences of an excessive stress?" leads students to traverse the chapters related to "physical environment", "school failure" and "adaptation disorders". In this way, the appropriation of the material is no more linear, as in a book or a course, but transverse. Students must connect their knowledge, co-ordinate them, confront them. The nature of the tasks they have to conduct is multiple (search of information, quick reading, information association, answer to some precise questions, ...).

4.4 Flexible help

To facilitate the information search, students can use a flexible help. During their exploration, students can thus take advantage of various degrees of assistance. The mode "free exploration" proposes the usual tools for searching information such as tables of content, index or other glossaries. The mode "guided browsing" provides a video of the professor as well as an explanatory text, both specifying the problem and indicating where the theme of the selected challenge is present in the table of contents. Lastly, if this guidance is not enough, users may obtain a "marked itinerary" which opens the general table of contents and indicates the chapters or sections where the theme is discussed. Students then only have to explore systematically the marked chapters or sections.

4.5 General knowledge tests

Each challenge also includes a test (a multiple choice with about ten questions) which allows students to evaluate their current knowledge level, and to verify, at any time, if they have acquired sufficient knowledge in the field of the challenge. In the event of false or missing answers, links allow to directly reach parts of the content that must be understood to answer the question. This test can be carried out in the beginning or at the end of the work. At the end of the exploration, such a test allows to control the acquired knowledge; earlier in the process, this test can also be useful to guide students in their browsing process (in the same way as in the guided browsing or the marked itinerary described above).

Figure 1 illustrates and summarises the concepts developed for this course.

[figure 1]

5. Evaluation of the experiment

5.1 Mechanism

All the students registered within this course had followed beforehand, during the winter semester, with the same professor but in traditional lecture conditions, a pedagogical psychology course on "learning and motivation theories". This situation offers experimenters a good opportunity for comparisons.

The experiment has been completely observed. At the end of the winter semester, a first survey allowed us to know the kind of participants and to collect students' expectations and fears. During the summer semester, regular interviews with some voluntary students allowed us to understand the advantages and disadvantages they were feeling when facing this new form of work. Finally, in July, after the first examination session, a questionnaire was sent to all the 150 students of the course. Table 1 gives a summary of these results[2]. In addition, 3 students were observed during their browsing and learning activities (Borgognon *et al*, 1997).

[table 1]

5.2 Results

Analysing these sources of information emphasises several interesting observations:

- One of the acknowledged objectives of the experiment was to reduce the place and time constraints that strongly weigh on the university. This objective is incontestably achieved, since two thirds of the students took the opportunity to work at home, mainly during the evening and the weekend, or during the "non-class" periods.

- The work schedule being no more determined by the regularity of the traditional course, the rate of use of the system was very variable. Indeed, the data recorded in July showed that some students worked up until 40 hours with the CD-ROM (1.4 times the time usually allocated up to now to the traditional course), while others devoted up to now only some hours, considering that they will work more during the summer holiday. This disparity can be explained however if one considers, on the one hand, the fact that two thirds of the students have chosen to print parts of texts and to study thus the material starting from a paper document (see below). In addition, it is necessary to note that it is completely possible that students having worked the more are those who tried to pass their examination in July, the others waiting for the summer holiday to start to study the material.

- The time necessary to understand the tool - not to be confounded with the time of study, is not to be underestimated. The two hours spent to present the CD-ROM and to explain the different potential uses have been judged insufficient by most of the students. Even after several working sessions, some students used only a small part of the features presented. The appropriation of the tool is done step by step (Borgognon *et al*, 1997). During the first step, students are satisfied with basic mechanisms, allowing only minimum operations with the system. It is only in a second step, when they feel at ease with this minimum of knowledge, that they seek other means of interaction. The tool presentation strategy has thus been modified accordingly for the second year of the course, on the one hand, by giving the CD-

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[2] For detailed observations, see (Perret et al., 1998).

ROM earlier in the year, before the end of the winter semester and, on the other hand, by proposing at least two presentations, on both sides of the spring break.

- If apprehension is clearly evidenced at the beginning - 50% of students confessing before the experiment that they felt somewhat anxious facing this innovation, this first reserve no longer appears, in most cases, in the second questionnaire. This survey, proposed at the end of the six-month period of the study, showed that 81% of students were satisfied to very satisfied with the experiment. In particular, they pointed out its pedagogical quality as well as the advantages of the hypertext and challenges strategies offering the opportunity to access the content using different approaches.

- The examination of the learning practices still requires a thorough analysis. One can however notice that two thirds of the students preferred to work on a printed version of the texts present on the CD-ROM. For them, the use of the CD-ROM was only occasional, to discover a video or a research report for instance. Several reasons seem to explain this attitude. First of all, reading on the screen is considered to be more painful than reading a book. But the analysis undertaken by (Borgognon *et al*, 1997) reveals another aspect of the problem: the significant search for transfer opportunities from the common learning strategies to the new world; thus, highlighting or annotating paper secures students who prepare an examination much more than all other approaches.

- The opportunity to periodically control their own work and to test their own knowledge seemed to be a significant potential of the system. Thus, if only 37% of students said they had consulted the additional documents systematically or in most part, and if only 45% of the respondents had consulted the whole or the majority of the video sequences provided, 75% of the experiment participants made

systematically or partially the knowledge test associated with each one of the challenges. 33% of them did this even twice: at the beginning, to test their initial knowledge, and at the end, in order to reassure themselves on the relevance and the precision of the knowledge acquired.

5.3 Effectiveness of the procedure

The impact of this innovation on the students' learning has also been measured by a comparative study of exams results. At the final examination, all students had indeed to answer 20 short questions, ten of which referred to the content of the winter semester (learning and motivation theory), and the other half to the content of the CD-ROM (adolescent psychology). The results were very encouraging. Indeed, in July and in October, the results obtained by the students were superior for the part related to adolescent psychology (and hence learned during the experiment) to the part related to learning and motivation theories (taught before the experiment in a conventional way). This difference can by no means be attributed to possible simpler questions or to a form of a recency effect, for example. Thanks to an additional question[3] associated to the use of the CD-ROM, it has been possible to compare the performance carried out by those who had a good knowledge of the system with the results obtained by their colleagues who had not or too little used this new resource. To answer such questions correctly is certainly not an absolute proof of an intense use of the system. However, one can reasonably estimate that the risk to see a student answer incorrectly such question while at the same time having used the CD-ROM sufficiently is at least as large as the

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[3] Here are two samples:
- *on the CD-ROM, when a challenge has been selected, what has to done before the content can be accessed ?*
- *on the CD-ROM, what has to be done to get information about an author's life ?*

opposite risk, consisting to correctly answering without having used the CD-ROM. In any event, one must admit that an approximation of the system use with such questions is undoubtedly more reliable than that that one could have received from a direct question on the use of the CD-ROM.

The comparison of the two groups allowed us to notice that the performance improvement during the summer semester was only present for students having sufficiently worked with the medium to give a correct answer to this additional question (T_{97}= -4.84, p=.0001), whereas the performance of other students were strictly identical both semesters (T_{39}=.62, p=.5405 NS). The quality of the improvement in learning can thus be attributed to the new system.

6. Conclusion

So familiar to the internet surfers, Netscape offers interesting possibilities for the design of hypermedia documents for teaching, even when one does not resort to the internet. The present experiment highlights indeed that it is not only possible, but also completely suitable to use this environment to propose course documents.

To avoid the 'lost in the hyperspace' problem, while preserving the flexibility of browsing non-linear content, four techniques have been adopted. The first consists in clearly defining the nature of the content structure as well as the structure of the proposed links. The second is to limit the links inside the same structure, so that one can only jump once and come back. The third technique is to assist students within their search so that they are pushed to use frequently the browsing capabilities of the system. The fourth technique consists in organising the whole as a problem solving system with challenges, which effectiveness has been largely been demonstrated by research in the field of motivation (Malone, 1981) as well as in that of learning (Brien, 1994).

Effective regarding the didactical aspects, such situations certainly offer rich research opportunities. For instance, one could experiment the effects on the quality of the students learning the same hypertext but without the structure involving problem solving (the challenges), or in modifying the guidance concept.

To adapt a course content to hypermedia certainly modifies initially the learning strategies of students. Our study shows however that these strategies are, at the University level, sufficiently stable and flexible to be reused as soon as a minimal control of the system has been reached (Borgognon *et al*, 1997). Such an observation is completely in conformity with the research results on the importance of the meta-cognitive strategies in learning (Flavell *et al*, 1993).

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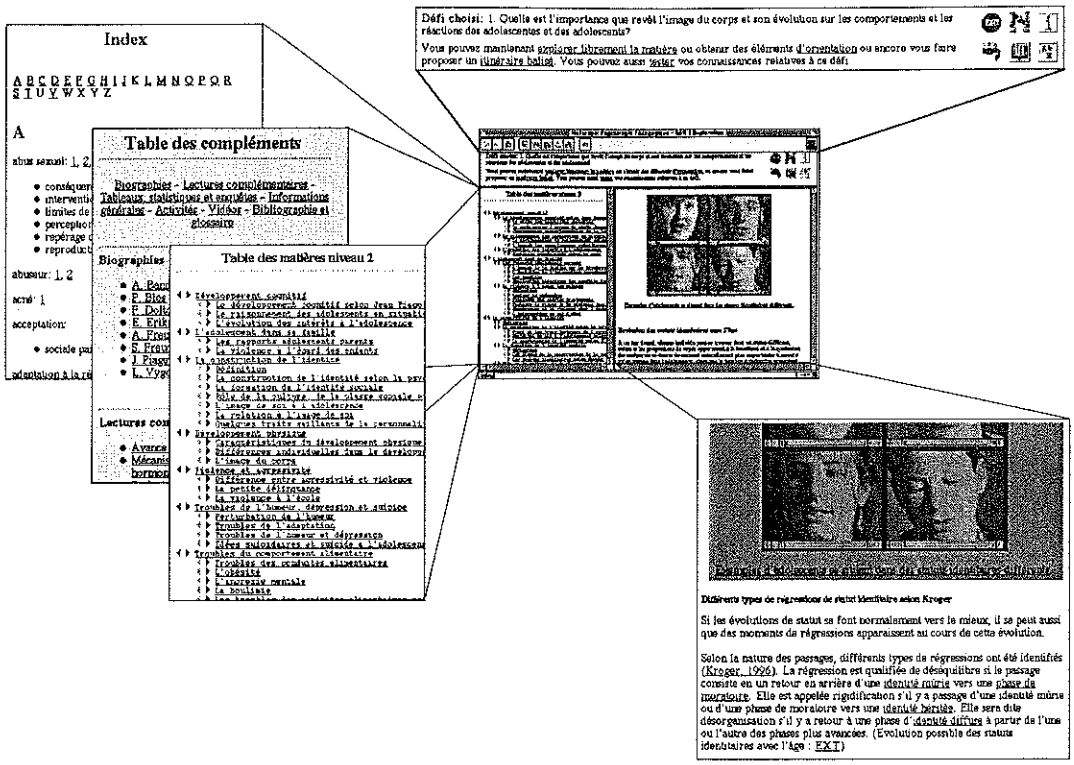

Figure 1 : In the middle, the working screen divided into three parts. In the upper part, the selected challenge, the different guidance options and the commands; on the left, the navigation frame with an index and different tables of content; on the right, the content frame which shows the material with texts, video sequences, activities and different hypertext links (for the glossary, the bibliography, the extensions, and so on).

	%	N
Total of students having turned back the questionnaire	38	53
Have viewed		
all the videos	17	
a majority of them	28	
some	37	
none	19	
Have read the additional documents		
systematically	7	
partially	31	
occasionally	49	
never	9	
Have made the built-in tests		
systematically	58	
partially	17	
very partially	9	
not at all	15	

Table 1: Some significant information from a questionnaire adressed to the students at the end of the course