# First results from distance learning experiment in algorithmic

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*Abstract*

*This paper presents an experiment we drive in order to test new pedagogical principles for distance and along-the-life training in our university. These principles are mainly supported by adding numeric supports within the traditional device. We describe the conditions of our experiment along with the first results we obtained. These results point out some of possible interests for the use of new technologies in education (such as introduction of simulation, personalisation of reading scenario or extension of communication possibilities). Our remarks also assist in determining a set of conditions that seems to be required in order to manage the introduction of these technologies (such as the necessity for a multi-support environment or the need for a close tutoring).*

## 1. INTRODUCTION

### 1.1. Experiments in pedagogical design

Several efforts are being made to have the traditional pedagogy go forward, especially for education in university, where the pedagogical aspects have been often neglected (Donnay & Romainville, 1996). Traditionally the pedagogy in universities is centred on knowledge production, nonetheless other aspects of the educational problems appears nowadays as essential, such as sharing, appropriation and application of knowledge (Leclercq, 1998). The application of didactical principles (Astofli & al, 1997) or of learning theories (Gagné & Medsker, 1996) lead universities to invent original ways of teaching. In this context, introduction of computer and learning software in education is a pretext to try new ways of teaching, *i.e.* computers are used as a mean to transform, more than a goal to purchase. Multitudes of examples are available in literature, for instance Baker (1998), Piché & al (1998), Blondel & Schwob (1997), Amerein & al (1998). The experiment we describe inscribe itself in the same movement, as our preoccupation when introducing new technologies is clearly to test new pedagogical situations in order to determine what can be improved.

### 1.2. Our context: Distance & along-the-life training

Technicians working in firms can follow along-the-life training in UTC, in order to obtain an engineer diploma. To follow the engineer training, they first have to acquire basic skills they might have missed or forgotten through their initial training. These basics are teaching during one year, while the students keep on working in their firms. Some of them may not be present in Compiègne for the courses and have to follow distance training. This paper focus on an experiment of distance learning of basics of algorithmic for students who prepare themselves to begin an engineer training.

Several ways of teaching this material have been tested, mainly based on books and videotapes. The main problem of these previous approaches was the lack of interactivity and adaptability of the supports to the specificity of each student.

This year, we decided to submit an original device, mainly based on a Web site and a CD-ROM. We thought that the particular characteristics of numeric supports could help in introducing ways of teaching that could bring in more interactivity and help in taking into account each student personal needs. This personalisation problem can also be treated by introducing closer tutoring (Barthes, Boullier, 1998), what we jointly decided to do.

### 1.3. Device description

The device the students have this year is composed by the following parts:

- A Web-site[1] enables the course consultation, to make exercises and auto-evaluations after each chapter. A controlled access to the correction of exercises makes it possible to follow the students evolution in their training. They are expected to send their auto-evaluation results before being able to access the correction.

[1] http://www.hds.utc.fr/~webtrig

- A CD-ROM permits the off-line consultation of the courses' contents[1].
- A paper version presents a linear version of the lessons.
- Each month the students have one hour to meet the teacher and check if they well understood the concepts.
- The students can also ask questions more regularly by e-mail to a tutor.
- They also use a Pascal compiler to apply the algorithms they learn.

## 2. RESULTS PRESENTATION

### 2.1. Evaluation of the experiment

The first remark we can make is that our approach seems reasonably efficient, since the students learning this way obtained similar results to the first exam than the students following classical courses. In order to deeply evaluate our experiment we sent a questionnaire to the students. We used this questionnaire along with the remarks we already capitalised since the beginning of the training. This set of elements allows us pointing out the strengths and the lacks of our device. In the following paragraphs we submit a thematic development of the principles we identified as essential in our approach. Some of these aspects are not still completely treated, however they have been identified as important interpreting the present lacks of our device.

### 2.2. Multi-support environment

Each technical support has its own way of representing and transmitting information. A traditional pedagogical device is composed by a large set of supports, such as paper documents, oral presentations, slights, blackboard, … Our position is clearly that the numeric support is a supplementary element in this set, and not the universal one that would replace the others. As described previously, our experiment is based on several supports (numeric ones, but also paper documents, human interventions, …) and we notice that each of these supports is used by the students. Moreover we can determine specific roles the supports have in the learning process, du to their particular proprieties in term of:

- information representation and presentation (textual, visual, sound)
- reading scenario (linear or not)
- readability and usability (screen, paper)
- technical constraints (cost, availability)

Let us present the roles that clearly emerged in our precise case:

The Web site is used to access dynamic information, *i.e.* information that is expected to change in time. For instance the exercises' corrections are accessible when auto-evaluation have been sent and the exams memory is refreshed each semester. The cost of on-line consultation prevents students from using the Web for static information they already have on other supports.

The CD-ROM documents are used for the advantages provided by a non-linear consultation. It makes it possible to have a personal approach in the reading choosing between various scenarios the teacher offers. It also allows more efficient consultation when doing exercises or programming algorithms, thanks to the links between concepts. Nevertheless the readability problem linked to screen visualisation hinder hard concentration on texts.

Paper documents remain imperative, for the students generally begin with them. They prefer these documents to deal with new concepts, in order to concentrate their attention on them. Despite the paper support remains the first entry, when the concept is globally understood the students can profit better the advantages of other supports, and search for more personal deepening.

### 2.3. Tutoring

The second aspect that deeply emerges from our experiment is about teacher intervention in the learning process. Two main means exists to help the teacher in the follow-up of the students works: The auto-evaluation (after each chapter the students are expected to send a form with the time they spent doing the exercises) and the meeting once a month between the students and the teacher. We observe that the students hardly work when the meeting comes closer, and the students confirm that the auto-evaluation principle help them in being regular and scheduling their work.

Moreover the students ask more means to be followed-up in their learning process: For instance personalised corrections and remarks about their works, indicators about exercises (difficulty, expected time to do them, …), more elaborated auto-evaluation (MCQ with automatic correction and work suggestion), …

We also test another kind of tutoring, based on email communication. Each student can send questions on points they do not understand, on aspects them want to be developed, on advice they request about their methodology, … The fact that the students have to draft their question is very interesting for they are lead to correctly formulate their problem. They realise the interest of such an approach, because writing their questions they often find themselves the solution.

### 2.4. Common database

The Web site provides some elements of the memory of the teaching the students can refer to (for instance the exams of the past semester, with their correction). Larger expectations have been detected on this aspect: samples of programs (especially on difficult points), sets of algorithms, other kinds of exams, different courses, … Several research project actually work on pedagogical databases, for instance ARIDANE (Forte &

[1] The students are lent a computer and an Internet connection in order to use these electronic tools.

al, 1996) or SEMUSDI (Delestre & Rumpler, 1998) and could help in constituting and organising such a pool of information.

Though the main preoccupations of the students is to benefit from the questions asked by the other ones. Whereas in a classical classroom each one profits from the intervention of each one, in distance learning case, students worry not to ask them all the questions they should. In order to solve this problem we shall stock and index the most relevant questions of the students in a common database. The students would be able to explore the general problems that exists, so that they could check in the database if their problems have already been answered and/or if it does not exist problems they would not even have detected.

As the identified problem is widely to allow the students sharing their impressions and problems, this database will be set in a global environment. In this environment the students will be able to argue and share their idea. We are designing a system in which students can ask questions, which other students try to answer, under the tutor's control.

### 2.5. Interactivity and simulation

Whereas the specificity of paper documents is the spatial representation of information, the specificity of numeric documents is the calculation the computer does on these documents: "The numeric information is calculable and only calculable", translated from Bachimont (1999). Written text enabled the spatial representation and the persistence of information with time, whereas oral information was intrinsically ephemeral. Thanks to these new possibilities, new knowledge that could not be formulated by oral appeared (for instance tables make it possible to point out relationships that can not be describes orally) (Goody 1979). Numeric documents equivalently bring new potentials of information representation, based on dynamic calculation.

The main lack of our present device is the poor use we make of the calculation potential. Our experiment underlined specific didactic points that could be reinforced using new approach. For instance several students have problems to manipulate Conway diagrams, we can easily imagine helping them with dynamic diagrams they could interactively use. It will be a complement to classical exercises. We detected several didactical points that could be developed on the same model: The manipulation of variables can be illustrated by simulators that execute a program showing the variable states at each step, a pedagogical compiler can help in explaining programming errors (whereas students usually prefer trials and errors method), … Of course our domain provides easily applications, because the calculation specificity of the numeric support is particularly adapted to algorithms simulation.

## 3. CONCLUSIONS AND PERSPECTIVES

### 3.1. Evolution of the device

In order to reinforce the positive aspects of our experiment and to introduce the new principles we identified, we plan new developments to have our device upgraded.

The Web site is being improved with more elaborated auto-evaluation, based on Multiple Choice Questions. We inspired of pedagogical experiments on evaluation related in Leclercq (1998). These kind of MCQ associate to each answer a certainty rate, in order to prevent people from answering randomly and to determine their profile in terms of self-insurance and mastering of the concepts. These auto-evaluations also favour the criticism of students, with possibilities of several good answers or none good answer for a question.

The CD-ROM, too much close to the Web site, is largely redesigned, introducing new ways of accessing information, more interactive exercises, simulations, and some playful aspects (based on stories, agents and quests from Pajon & Polloni (1997).

A pedagogical compiler is also being made. Its objective is to enable students to write programs in a sublanguage of Pascal and to write algorithms in a specific pseudo-language. The compiler will determine if the program syntax is correct, helping the student to progressively find his errors if not. Then it will determine if its semantic is correct comparing to the objectives given to the students (the method we will use is mainly based on the verification of the outputs produced by the program related to determined inputs). The compiler will be able to point out the part of the course linked to the errors made, to simulate execution in order to demonstrate good or bad working of the program, …

We shall also develop the database and the communication tools we described in the previous chapter.

### 3.2. Connected experiments

The initial-training students of UTC already use the Web site to complete their lessons, especially to prepare exams. The next semester we will try a deeper experience, isolating 20 students from the 150 that constitute the pool of students learning bases of algorithmic. These 20 students will not follow the classical courses with the others but will spend 4 hours a week with a teacher in a special classroom with computers. They will use a specific device based on the Web site, the CD-ROM, and also the blackboard, the teacher oral intervention, … Our goal is to test new ways of teaching, allying traditional and new aspects, in order to determine what in the learning process can be improved.

Our purpose, with these two main experiments, is to identify basic principles that improve a learning process by benefiting from the specific strengths of the numeric support (such as the ones we began to describe). We then plan to develop a design method to assist in realis-

ing multimedia and interactive learning software that have to be integrated in a larger pedagogical device.

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