7 Collaboration in a Multimedia Laboratory

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7.1 Networks in Science Teaching

7.1.1 Introduction

In France, several networks engaged in the renewal of education and teaching are based upon tools of Information and Communications. With this in mind, the author set up the L.A.M.I.A. laboratory [1] in a training college (I.U.F.M.) [2] in the North of France. The notion of network is at the core of this paper: firstly, to present R.U.C.A.[3] and the influence of the work of the author in R.U.C.A. on the creation of L.A.M.I.A.; secondly, to explain the quick development of the laboratory, especially in mathematics; lastly, to present the development of collaboration and distributed cognition in the North of France.

7.1.2 *La Main à la Pâte* (Hands On Teaching)

Among the educational networks that have been created in France, the best known is "*la main à la pâte*". It was initiated by Georges Charpak, Nobel prize winner in physics, for the renovation of science teaching in primary schools, and was the continuation of the trend in renovation launched by Ledermann in the United States. It is led jointly by scientists, researchers at I.N.R.P. (the National Institute for Pedagogical Research) and by primary school teachers. A web site [4] presents the experiments carried out in schools, offers an on-line library for primary school teachers and is a means of contact and work with researchers in sciences. In this network, the technology is mainly used as a tool of communications and mutualization.

[1] Laboratoire Multimédia Informatique et Apprentissage,
http://www.lille.iufm.fr/labo/prologlabo.html
[2] Institut Universitaire de Formation des maîtres, (training college)
http://www.lille.iufm.fr
[3] Réseau Universitaire des Centres d'Autoformation
[4] http://www.inrp.fr/lamap

7.1.3 *On-Line University*

Several French science universities have cooperated in order to create a set of multimedia products covering the first year curricula. The U.S.T.L. [5] is highly involved in this network, and its multimedia laboratory L.E.M.M. [6] runs this network. The author personally takes part in the production of mathematics unit credits in the L.E.M.M., and she is the head of L.A.M.I.A.. The two laboratories L.E.M.M. and L.A.M.I.A. cooperate. The history of the network of scientific universities and its realization are interesting and important to understand the development of technologies in education in the North of France.

Fig. 7.1. A self-learning center in Paris 6

History of the Project. An academic science network of self-learning centers, (R.U.C.A.) was set up in 1987. Eleven universities are currently part of this network: Aix-Marseille1, Bordeaux 1, Grenoble 1, Lille 1, Nancy 1, Nice, Paris 6, Paris 7, Paris 11, Toulouse 3, Tours. The R.U.C.A. centers were first mainly concerned with continuous training and used custom made educational material. The first change was in 1994 when the decision was taken to create their own resources and to start didactic research about the contents. The second change was that, in spite of scattered resources, the students were to use these resources in their initial training. For example:

[5] Université des Sciences et Technologies de Lille, http://www.univ-lille1.fr
[6] Laboratoire d'Enseignement Multimédia Médiatisé
http://www-lemm.univ-lille1.fr

- simulations of devices used in experiments (e.g. oscilloscope) that allow concentration on practical work done by students during their experiments, and in turn relieve the task of teachers and allow them to make better use of their time;
- videos presenting experiments so that the students can see them at their own rhythm;
- self assessment tools used for the preparation of examinations.

The Renewal of the First Academic Years at University. The development of mass education and the increasing duration of studies have led a large amount of students to university and have increased their diversity, in terms of social background and of previous training. Most academic teachers are not prepared to cope with the problems caused by this diversity. Universities were urged to modify their teaching in order to reduce the failure rate during the first years. This was done by the setting up of tutorial sessions, whereby initiatives were taken by motivated local teams to develop modern teaching methods and that led to very interesting successful results, especially in allowing large numbers of students to see the experimental working using visual support.

Premier Cycle sur Mesure **(Tailor Made Teaching).** During the 1990's the R.U.C.A. teacher teams gained experience by taking part in various educational developments, systematical gathering of educational resources for the centers and developing training material for them. The teams were able to assess the R.U.C.A. project, software packages and resources available for the students at that time. Although these resources were up to date and interesting, their structures were diverse and not unified in contents and they were far from covering the curriculum of the first two years. For this reason, in 1995, the R.U.C.A. decided to launch the P.C.S.M. project, (in French, *premier cycle sur mesure*) meaning "tailor made classes" in order to cover a unified method of teaching the first two (scientific) academic years including self training material. This project was financially supported by the Ministry of Research and Education [7].

The characteristics of the R.U.C.A.'s graphically executed productions were submitted in 1998, to a specialized company that had a group of experts in the line of teaching in order to draw the common lines and to suggest a general model. This model was discussed, improved and adopted by the network. The P.C.S.M. project then took the name of *On-Line University.*

On-Line University **U.E.L.** The objective is the creation of pedagogical resources entirely covering the early years of learning at scientific universities in physics, mathematics, chemistry, biology and technology. Thanks to the

[7] http://www.education.gouv.fr

Fig. 7.2. Entrance of the online university UEL

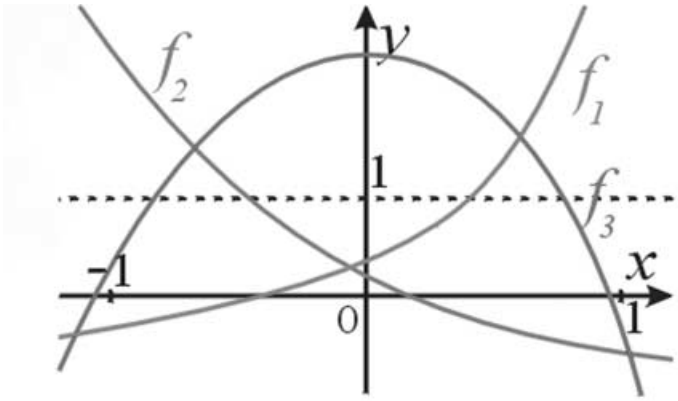
R.U.C.A. history, progress is not the same in all disciplines. Work is more advanced in physics, for which the program is almost over. It has just begun in biology, and in mathematics and chemistry two years of work have been invested.

The site national of the *On-Line University* will be on the internet with a presentation of the project, a guided tour and all the modules at the address `www.univ.enligne.education.fr`.

Access to all products will be free of charge without limitation of the time of consultation. All public establishments in France will have the possibility of downloading the products freely, without charge. Public establishments, who sell formation, will pay a license fee. Outside, private or foreign establishments will contract with CERIMES and pay a commercial license fee (`www.cerimes.education.fr`).

Currently, the UEL site contains about 600 hours of training which are subject to testing and assessment by the universities. Academic resources contain 330 visual animations, 410 video films and 600 computer simulations (java applets) which are within a unified presentation and a common graphic framework; they can be installed onto any type of server and currently occupy about 2 GB of disk space. The on-line questionaires of the internal "observation of practices committee" use CGI - PERL language. The contract conditions are the following ones.

1. Products must be platform compatible. The choice of standards (HTML, JAVA,) was decided, with the use of multi-platform languages (HTML, javascript, Java). These constraints are very strong because total browser compatibility of languages such as javascript is not effective. Anyhow,



	Vrai	Faux	NSP
$\forall j \in \{1,2,3\}, \exists a \in [-1,1], f_j(a) = 1$	○	○	◉
$\exists j \in \{1,2,3\}, \forall a \in [-1,1], f_j(a) = 1$	○	○	◉
$\exists a \in [-1,1], \forall j \in \{1,2,3\}, f_j(a) = 1$	○	○	◉
$\forall a \in [-1,1], \exists j \in \{1,2,3\}, f_j(a) = 1$	○	○	◉

Fig. 7.3. Exercise in logic on quantificators

the R.U.C.A. keeps track of technological progress and further evolutions are already in preparation (XML ...). In mathematics, the use of formal computation has to be integrated in such a way that software package (Mathematica, Maple ...) is not necessary on the client computer.

2. Pedagogical structure has to be made flexible. The *On-Line University* program is conceived as a juxtaposition of independent modules. Each unit can be altered and modules can be reorganized by teachers for their own pedagogical needs and internal use in their university. The graphical framework reflects a rather classical teaching structure, with two entries:
   Activities: learning, practicing, simulating, observing, evaluating.
   Themes: with the set of activities available on a given theme.
3. Availability: for this experimental year, modules were supplied to all public universities which had signed the agreement. Modules must be freely accessible to students registered in universities. The *On-Line University* is a collaboration and a collective property of its creators. The license will be transferred to public universities or to educational companies in exchange of a financial contribution. Maintenance and a regular updating of resources are provided by the R.U.C.A.

Fig. 7.4. Menu with the five activities of UEL

A national, cooperative realization *On-Line University* is a very original creation in France based upon a network of several teams of creators. It is possible for the following reasons.

Unified piloting: A piloting committee created in 1997 organizes yearly work distribution between the R.U.C.A. network's eleven universities. While one of the universities designs a module, the others carry out a didactic analysis, suggest additions or modifications. As previously mentioned, the R.U.C.A. network has had a long tradition of collaboration and of sharing resources.

Realization by plural teams: While the modules are produced by teams of academic teachers as far as didactic content is concerned, engineers provide technical realization. This has led to the creation of regional academic laboratories of development. A competence distribution allows the cooperation between centers organizing technical training sessions and taking particular skills into account (especially concerning Flash, Java, etc).

Link with software industries: Appeals are made to companies, at a national level for the model, and at a regional level for specific computer problems.

Validation of the contents: These resources have already been tried out by twenty five academic institutions. A follow-up of the experiment is ensured with an internal *Observation of Practices Committee* piloted by the R.U.C.A. An external *Committee for Evaluation* guarantees the scientific methods of

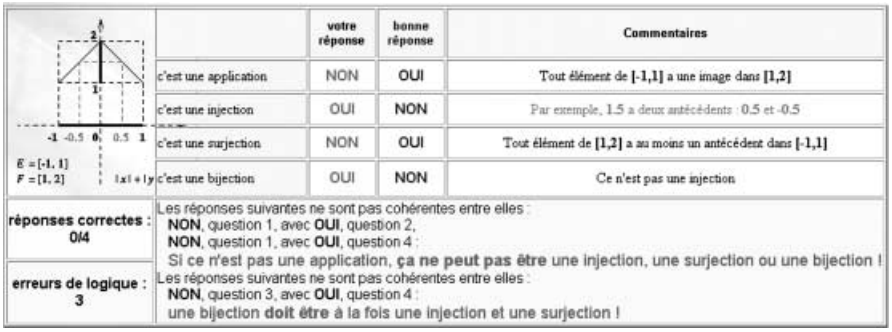


Fig. 7.5. Analysis of the logical coherence of answers

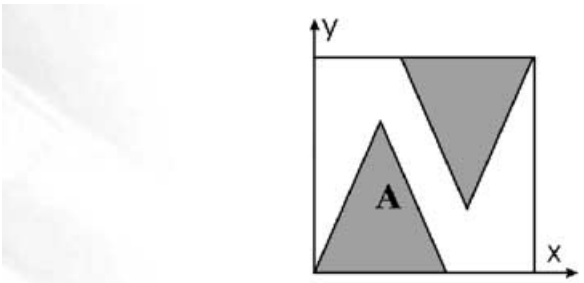
the observation. Two questionnaires are integrated into the software packages which allow a follow-up of usage: one questionnaire allows immediate remarks on the pages one has seen, and the other concerns the whole module.

Modules in Mathematics. They are shared according to the previous didactic researches and experiments in integration of computer tools in the education in each university (Bordeaux, Paris 6, Lille, Le Mans and Paris 7). Three modules have already been completed: vector space in Bordeaux, calculus (sequences and functions) in Paris 6 and a transition module [8] in Lille (logics, arithmetics and analytical geometry). New modules are scheduled: differential equations, Cn functions, linear algebra, integration, experimental mathematics (algebra and arithmetics). The problems for mathematics are the following ones.

Writing Problems: Writing while exploiting the possibilities of multimedia is not a part of the current culture of the authors. The use of animations and the possibilities of visualization bring deep changes in the conception of the creation of resources. As with the software packages of formal computation, the possibility of experiment in mathematics is still in its initial phase. A large progress can be seen with the use of applets in the new unit of *Differential equations* created by Véronique Gautheron. This in turn will give new ideas to the authors.

Problems linked to Mathematical Symbols: The whole set of mathematical symbols is not yet implemented in the browsers; these problems are treated at present with different techniques by the teams. Generally the teams of the R.U.C.A. do not use Latex or Tex and the choice of creating pictures for mathematical symbols was natural. In Lille, the mathematical team had worked with Latex and Tex for these last years and the resources were in

[8] by the author of this paper



	votre réponse	bonne réponse	Commentaires
$\forall x, \exists y, (x, y) \in A$	Faux	Vrai	Chaque verticale contient au moins un point de A.
$\forall y, \exists x, (x, y) \in A$	Faux	Vrai	Chaque horizontale contient au moins un point de A.
$\exists y, \forall x, (x, y) \in A$	Vrai	Faux	Chaque horizontale contient au moins un point qui n'est pas dans A.
$\exists x, \forall y, (x, y) \in A$	Vrai	Faux	Chaque verticale contient au moins un point qui n'est pas dans A.

Fig. 7.6. Analysis of the answers of an exercise

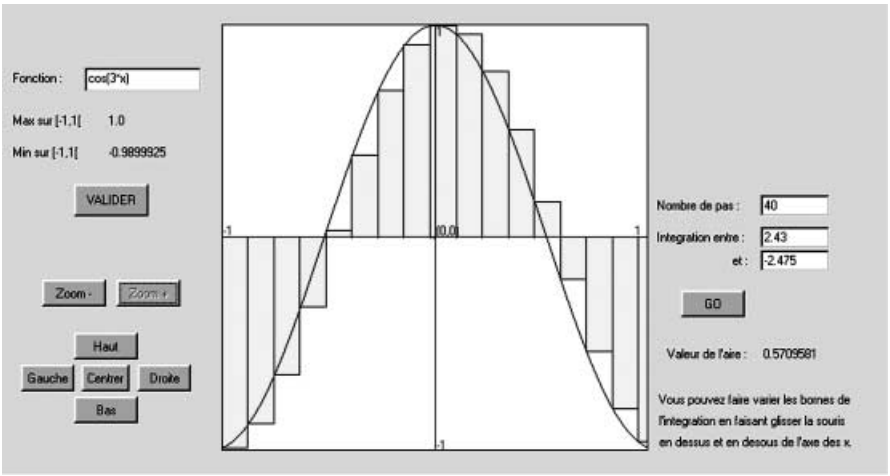


Fig. 7.7. Applet on integration

Latex. Therefore, while waiting for the implementation of mathML in the different browsers, the first choice was to use pdf files inserted into html pages. It was necessary to divide the files into small ones, and not to use the scrolling bar which produced a unpleasant trembling. We had to think again about all the contents of the units with the aim: *one page, one idea*. This solution was refused by the French Ministry. Therefore we changed all the pages using the *symbol* font. But this font was not available on netscape.

So we changed all the files for the third time. With the software package *Latex-for-html* [9] gifs were created for every mathematical symbol, four size gifs for each symbol. The same gif for a mathematical symbol is used in all the files and the next change, when mathML is available in all the browsers will be easy. The possibility of the use of mathML will also solve the problem of composition of symbols in the mathematical formulas.

The Problems are linked to the dimension of the realization of the *On-Line University* program. It challenges the authors with all the problems posed by the questions of innovation and by the evolution of the different models of teaching presently being debated.

1. The Problems of the Integration of Technologies in a classical curriculum. The possibility for a teacher to make a partial use of resources, to modify them and to integrate them into his (her) own courses is an essential point. The "*On-Line University*" modules will be completely effective if they are used as a tool by teachers (films and easy access to animations) and if the teachers advise students in the use of the resources by giving them precise work to do and also if an accompanying tutorial session is organized. A reflection on on-line services is to be developed.
2. The Problem of Guides. When teachers give precise personal work to do with the resources, it is more effective and more useful for all the students. Beyond the guides of studies already carried out, the modalities of use should be thought about and explanations should be developed. How to give the students the most effective help adapted to their various learning strategies? How to reconcile guides and develop the students'autonomy?
3. The Interest of the Multimedia Tool. For the students, this tool means working at their own rhythm, it also means individualized tutorial sessions for personal work, possibilities of visualization and simulation in science for the discovery of concepts and it allows the development of a better intuition. Personalized services for the students should also be created.
4. The Problem of The Integration of Resources in Education Platforms eventually allowing to combine the work with the teachers and a remote access to resources for personal work. This will be discussed in the last part of this chapter.

7.2 Technologies in Teacher Training

7.2.1 Important Efforts

These last few years, a very large financial support, often in association with European funds was made to equip universities, primary schools and secondary establishments. Altogether, the equipment of the establishments has

[9] on the C.T.A.N, (Comprehensive Tex Archiv Network), Latex-or-html is rather difficult to use, as there are bugs in this version

grown very fast. The I.U.F.M. institute of the *Nord-Pas-de-Calais* received a large amount of subsidies and its local centers are now well equipped. Many colloquiums are organized at several levels for management staff and teachers. A national portal for the visibility of educational resources on the Internet has just been created for primary and secondary school teaching [10] and another one for academic teaching [11]. In the *académie* of the *Nord-Pas-de-Calais*, an operation is launched thanks to the initiative of the Chancellor-Rector to equip the establishments with computers connected to a network and to Internet; these classrooms are called les *classes pupîtres* (pupître = school writing desks). The problems of technical follow-up, the use of these classrooms by the teachers at the moment remains unresolved.

7.2.2 Lessons from Recent History

How to avoid the situation again of the *Plan informatique pour tous* (plan for computer for everybody) where some years ago, many establishments were equipped with computers which were used only by some colleagues keen on computer science among the general indifference of the other colleagues? (The same thing happened for audiovisual equipment). A reflection on the previous problems is essential.

7.2.3 Developments in Cognitive Psychology

The lack of previous realizations is explained partially by the state of research in cognitive psychology and by software package performance. At the early stage of its development, computer-assisted training was linked with behaviour theories and led to many pieces of software being produced where students were strictly guided on a route of questions and answers according to their previous answers. This aspect of "Multiple Choice Questions" quickly found its limits in front of the difficulty for researchers to elaborate a "model of the pupil". It had the same limits as the underlying conceptions of teaching, but it had also positive aspects on the training of students or pupils.

7.2.4 A Qualitative Change

With the development of artificial intelligence, some expert systems were created and intelligently assisted training by computer was developed, but its realizations remained marginal. The current state of computer software development with systems based on hypertexts and the use of Internet, introduces a qualitative change which makes a larger use of these tools in training possible.

[10] http://www.educanet.education.fr
[11] http://www.educasup.education.fr

7.2.5 The Integration of Technologies

During the last three decades, The training of teachers in the use of computers mainly relied on training in the tools and in programming languages: basic, pascal and so on. With the development of friendly user tools, the problems are quite different. Even if techniques are very important, didactical content becomes essential for teachers. Production can be done by specialized laboratories or by industries. The main objective is the integration of these technologies in teacher training and in the teaching of pupils.

7.3 L.A.M.I.A.

7.3.1 Some Strong Ideas

Why have a laboratory of multimedia creation within the I.U.F.M.? The new tools (hypertexts, hypermedia, animations, virtual reality ...) were developed for other aims than training, in particular for the accessibility on the Internet of large quantities of data. They present a great interest in the training, by allowing much more freedom, and a bigger initiative for the person who is learning. Reflection on the uses of these techniques for training is still at an early stage, but one should bear in mind that some strong ideas can be drawn from research on practices.

Fig. 7.8. Web site of the LAMIA laboratory

- Systems based on knowledge require considerable elaboration.
- To be extremely useful, they must be integrated into the training and not placed side by side.
- To make the best use of it, one has to privilege an active use of hypermedia by the trainee to solve problems or to carry out personal works given by their teachers.
- If creation is sometimes the fact of a minority of teachers, full integration requires interest and implication from a lot of teachers.
- This implication can not be obtained at once. Nothing will be made without the teachers' implication and some technocrats' speeches saying that these technologies and the computers can replace the teachers have a very negative effect. The point is not to lower the role of the teachers but to allow a richer and more interesting work, and a development of interactions between the trainer and the trainee.

7.3.2 The Creation of the L.A.M.I.A.

These ideas motivated the creation of a laboratory within the I.U.F.M. in September 1999. The essential point is that the creation of tools integrates the state-of-the art research in didactics and in cognitive psychology and the knowledge of experiments which are carried out in other countries. The management of the I.U.F.M. allowed this creation to take place by taking money from their own funds in the equipment of five computers powerful enough to make multimedia creations, and four people of different disciplines are engaged full time in the laboratory.

7.3.3 The Role of the L.A.M.I.A

When it was created, the following tasks for the laboratory were defined

- To lead activities of research and of development in the domain of the use of multimedia tools and of information and communication technologies, by the creation of synergies between the existing capacities within the I.U.F.M. and within the *académie* and by the creation of new skills.
- To analyze the possible effects of the multimedia tools and generally of the new technology tools on the teaching practices, on the strategies and on the processes of learning, to analyze the acquisition of knowledge which they allow and the nature of the transmitted or acquired knowledge.
- To contribute to the creation of new tools, whose use will be recognized as necessary, as well as the analysis of the uses and of the practices implementing them.
- To animate a workshop, transverse to the thematic and (or) disciplinary working groups; this workshop has the specific task of validating the capitalization of the reflection and of production. The workshop was dedicated to the contributions of cognitive psychology. This year it will be focused on collaborative work.

A Scientific Committee assesses the productions before publication on the I.U.F.M. server. Some software packages useful for several disciplinary domains are already available for the trainees on the server.

7.3.4 Researches at L.A.M.I.A.

The research at L.A.M.I.A. is characterized by the following philosophy:

- Support for innovation and for creation. Cooperation for the creation of resources and for access to knowledge. Creation of pedagogical tools as a modality for further education.
- The development of interactions between the creative teachers in schools and the researchers. For example, the development of interactions between the trainers, (primary and secondary school teachers, university teachers), and the researchers in didactics and in the history of mathematics.
- The experimenting of the tools with a return from the "rank and file" teachers, a return allowed by the tools of communications.
- Distant work: tools for cooperative work do not require direct physical presence.

7.3.5 The Hypothesis of L.A.M.I.A.

The first hypothesis of the L.A.M.I.A. laboratory is the importance of a real use of technologies in the training of teachers. If these tools are useful for the teachers during their training, if the trainees are directly engaged in a creation, they will find how to make a relevant use of these technologies with their own pupils later.

The second hypothesis is that the process of creation of pedagogical material by teams composed of people from different backgrounds, aiming at pooling resources, leads the teachers to integrate the questionings particular to the research in their teaching practice. It is an important way of renewing teacher training and to form reflexive practitioners [12]. The laboratory has a fundamental role in this process for the interaction between researchers and the "rank and file" teachers, for the teacher training through the means of research.

7.4 Training of Mathematics Teachers

Because of the close relations which exist between mathematics and computer science, the tools and the teams of creation in mathematics are numerous. But to be able to understand the use of technologies inside the I.U.F.M. [13]*, it is necessary to give an idea of the training of mathematics teachers in France.*

[12] Schön, D.A., The reflexive practitioner, how professionals think in action.
[13] http://www.iufm.education.fr

The I.U.F.M. gathers all the actors of teacher training in the same institute. The professional dimension and the didactics of the disciplinary domains have begun to be taken into account in the educational system. An opening towards research methods, towards the link between basic research, research for development, and research for innovation is in progress.

7.4.1 The First Year in the I.U.F.M.

In France, the mathematics teachers are recruited by two national competitive examinations. The first one is the *c.a.p.e.s.* (Certificate of professional capacity for the secondary school teaching) at the end of three years of university studies *licence* (Bachelor's degree). The second one is the *agrégation* at the end of four years of university studies, *maîtrise*, (Master's degree (Hons)) for admission to teaching at semior high school level. Each of these competitive public examinations has two written exams. After the written exams, the successful candidates take two oral exams for admission. These competitive examinations are prepared in the first year, sometimes with an important part of the training at university.

7.4.2 The Second Year

The teaching in full responsibility in a class is a central part of the second year, and two periods supervised by a teacher in two different establishments give the trainees a better knowledge (of the establishments). Training is organized within the institute with two parts, mathematical training and compulsory teaching of the educational system, of the management of classes and of the information and communications technologies; many optional subjects such as psychology, didactics or the history of science are proposed to the trainees. A dissertation, *m*émoire is compulsory for the trainees of the *C.A.P.E.S.* and optional for those of the *agrégation*.

- **The Responsibility of a Class After his (her) Success in the First Year**. The student becomes a trainee, P.L.C.2 [14] with a period of full responsibility in a class at the beginning of the school year. In the establishment where they are teaching, they are helped by a mentor, a more experienced teacher of the same establishment. Some problems arise from the establishments where the trainees have their classes. A strong minority of the trainees, (about a quarter of them) get and are responsible for some very difficult classes. The difficulties of the trainees are worsened by their inexperience of teaching: they often use poor pedagogical material which is not very interesting for the pupils.
- **Mathematical Training.** The trainees receive within the I.U.F.M. a training during two terms of about ten days of mathematical tuition by

[14] Professeur de lycée et collège

the mathematics teachers called F.A. (associated trainers), (one of middle schooling and one of senior schooling), recruited part-time for several years. The I.U.F.M. of the Nord-Pas-de-Calais mainly applies a model of a rather standard face to face training with help from experienced teachers. Research in educational science on the modalities of the following-up or on the accompanying of the training as well as the didactics of mathematics, their history and their epistemology are widely ignored.

- **The Professional General Tuition** is, according to the authority statements, one of the weak points of all the I.U.F.M. institutes. Besides the compulsory training, it is a training by some small units which are offered to the trainees; this tuition presents a lack of coherence. The same units are offered to all trainees whatever the level of the schools, (primary and secondary, general and technological or professional) where they teach, and whatever their previous background.
- **The *Mémoire* in Mathematics** of about thirty pages, is a collective work made generally by two or three trainees; this *mémoire* is a work of synthesis on a precise aspect of the professional experience of the trainees. They have to define a problem encountered during their teaching and they are asked to lay down the questions precisely. The aim of the *mémoire* is to articulate the experience of the work in class with a didactic analysis and a deepening of the mathematical contents. If it is reasonable, the trainees have also to integrate the contributions of the history of mathematics. This *mémoire* is guided by teachers who are involved in research work and who have themselves the experience of professional writing. A methodological help and didactical or historical complements are introduced during a workshop. The *mémoire* represents a real innovation of the I.U.F.M. and the guiding of the *mémoire* is similar in the department of mathematics to a work of directing research. In the department of mathematics, a team for directing *mémoires* has been constituted, and is run by academics.

7.5 Technologies in Mathematics

7.5.1 Current State of Uses for the *Mémoires*

The technologies of information and communication are an important help, both for the trainees and for the trainers, as a tool of cooperative work between the trainees for the *mémoire* and as a means of access to a library of on-line resources. E-mail is an essential tool, the trainees being placed all over the *académie*, they use more and more the network for educational on-line resources.

- A bibliographical data base [15] is available for the trainees on the website of the department.

[15] http://www.lille.iufm.fr/dep/math/resdoc/index.htm

- The department of mathematics began three years ago the creation of an on-line library [16] : the quality of obtained *mémoires* allows us to publish every year, on the network, a lot of these *mémoires* for the trainees or even more generally for the teachers of the *académie*.

7.5.2 Current State of Uses for the Research Teams

If one tries to analyze the current state of the uses of these technologies in domains close to the L.A.M.I.A., one can notice that they are in full development in the training of teachers of mathematics in the I.U.F.M. of the *Nord-Pas-de-Calais* under the following forms:

- As a tool of communication and exchanges between the trainers: an e-learning platform *Campus Virtuel* (Virtual Campus) [17] is used by the teams of research in mathematics and by groups of trainers.
- As a tool for production of pedagogical documents with a good typographical quality, with software packages for mathematical word processing.
- As a tool for the drawing and the experimentation in geometry, with software of dynamic geometry [18]. As a tool for data processing with the use of spreadsheet [19]. The diffusion of knowledge of didactic works on these tools is done by L.A.M.I.A.
- With the use of symbolic calculations available today in pocket calculators to develop mathematics experiments.
- As a tool in publishing and for calling the teachers of the region to experiment the on-line software programmes. Exchanges to improve software tools are now possible with *Campus Virtuel* (Virtual Campus).

7.5.3 The Teams in Mathematics

The C.R.E.A.M. is a research team [20] of the I.U.F.M. engaged in a long term programme. The purpose of this resource center for P.L.C.2 trainees is to offer some pedagogical situations which are rich and varied enough to be interesting even for problem pupils. It also aims at favoring or strengthening the understanding of the contents of teaching and to help teachers to rethink their relation to knowledge, in particular from the point of view of its genesis and of its construction rather than to its transmission as an achieved knowledge. The elaboration of the rewarding situations is the result

[16] http://www.lille.iufm.fr/dep/math/mempro/index.htm
[17] created by C.U.E.E.P. of U.S.T.L.
[18] Cabri, Cinderella, Geoplan, Geospace
[19] mainly for teaching statistics
[20] Center of Resource for Education and Help in Mathematics
http://www.lille.iufm.fr/labo/cream/entree.html

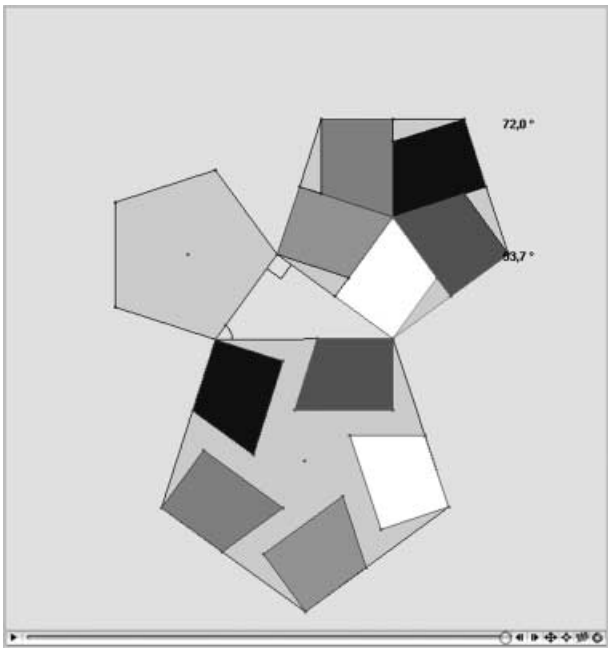


Fig. 7.9. A Cabri applet on the theorem of Pythagoras

of many years of experimental work as the practice of most of the members of the team proves it. The methodological choice focused reflection on some subjects by deepening various aspects: historical, epistemological, didactical and pedagogical ones with a study as complete as possible of the existing documentation. The site of C.R.E.A.M. will be upgraded in the forthcoming years. The team is composed of fifteen teachers from comprehensive schools and three university teachers and a lecturer. The team prepares the experiments for several situations, analyzes their consistency with the curriculum, criticizes them and works them out. For every situation, the analysis concerns the mathematical contents as well as the forms of management of the class which are the most adapted to every situation and to the personality of the trainee: teamwork, scientific debates, workshops. What minimal conditions should exist to achieve the targeted objectives? What help, (theoretical, epistemological and methodological) should the team give so that these situations could modify the teaching. What information should the team give so that the research for example in didactics or in the history of mathematics become accessible? Creating the site on internet was the opportunity for a reflection on the conception of a center of resources, on its definition, on the presentation of the lessons and in particular on the constraints of data processing. The members of the team had to cope with the requirements of questioning, of clearness and of the rigor necessary for the research.

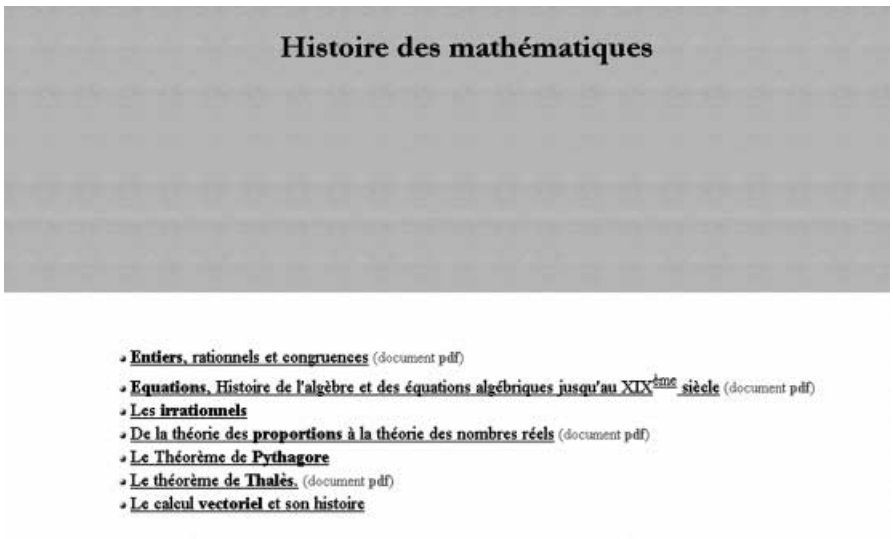


Fig. 7.10. The CREAM web site: history of mathematics

A6-3. The electronic schoolbag of the secondary school teacher [21] is a downloadable software program; it supplies a very important data base on the curriculum, on the exams of the *brevet* (standard grades, 4th year) concerning the last ten years in France, with a set of lessons and of exercises for the first form to the fourth form; the teacher can develop it and modify it the way he (she) wants, in order to create his (her) own database. A network of teachers is developing this data base and has begun to create software program called *Virtual blackboard*. The aim is to provide live illustrations of mathematical lessons in such a way that the teacher always faces his pupils. The techniques used are rather simple: use of Word, Power-point and software programs for geometric constructions. The aim is that any teacher, with really a minimum training, can adapt the software to his (her) own needs.

LILIMATH received in 1998 the first prize of a national competition (cervod) of software tools for training. A portal [22] on the net gathers the resources created by this team for primary schools (LiliMini), for secondary schools (Lilimath collège and Lilicé). All the sources and applets are downloadable. The aim is to develop free software programs that can be changed by the users, and tools for teachers to develop their own applications. The software must be usable on different computers and especially on the old computers sometimes still in use at school. It can be given to pupils for use at home or in the *documentation center* of the school. More sophisticated tools (java applets) are also provided. A wonderful *Parc d'explorations mathématiques*

[21] http://www.lille.iufm.fr/labo/6A3/index.html
[22] http://lilimath.free.fr

(mathematical exploration park) presents rich situations for interdisciplinary work for example *Croisière* mathematics for seamen ... This team animates a network with a forum and an association.

Fig. 7.11. Lilimath: entrance of the exploration park

GÉOMÉTRIX. This software program, written in the programming language prolog, uses the techniques of artificial intelligence; it received the second price in the previously mentioned competition. This software program is a help in the writing of geometric proofs by pupils in secondary schools. The use of this software program by teachers and the analysis of the problems solved allow a constant improvement of the data base of *géométrix*.

FUNCTIONS the learning of functions [23], in secondary technological schools; this downloadable software program allows an individual following-up of the works of the pupils and received the fourth price in the same competition.

GEOWEB illustrates a new direction of research with some creations made by the pupils themselves [24]. Open problems were suggested during free time

[23] http://www.lille.iufm.fr/labo/laboProjetsReal.html
[24] http://www.lille.iufm.fr/labo/laboProjetsReal.html

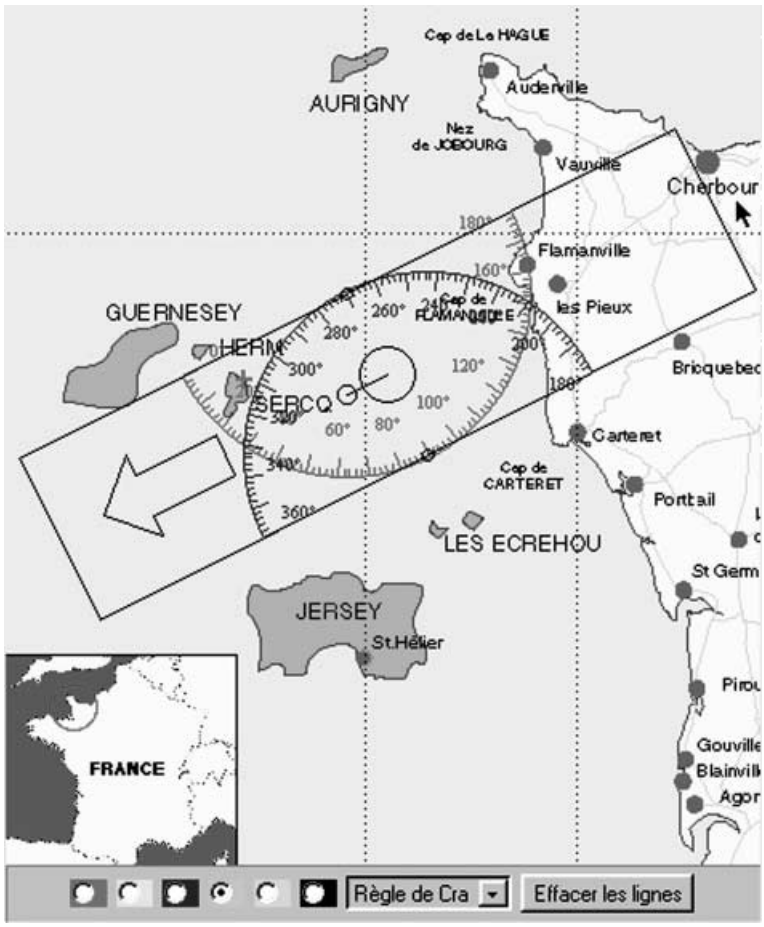


Fig. 7.12. Régle de CRA: a sailor's tool applet in the exploration park of Lilimath

(outside mathematical lessons) in a secondary school to motivate pupils who created files on the solving of these problems in geometry. They use geometric drawing tools and html.

BUTINAGE (picking up) software program [25] with a multidisciplinary use for research of the pupils on the Internet; the teacher uses it to prepare research themes and to select interesting sites for the pupils'work.

[25] http://www.lille.iufm.fr/labo/butinage/butinage.htm

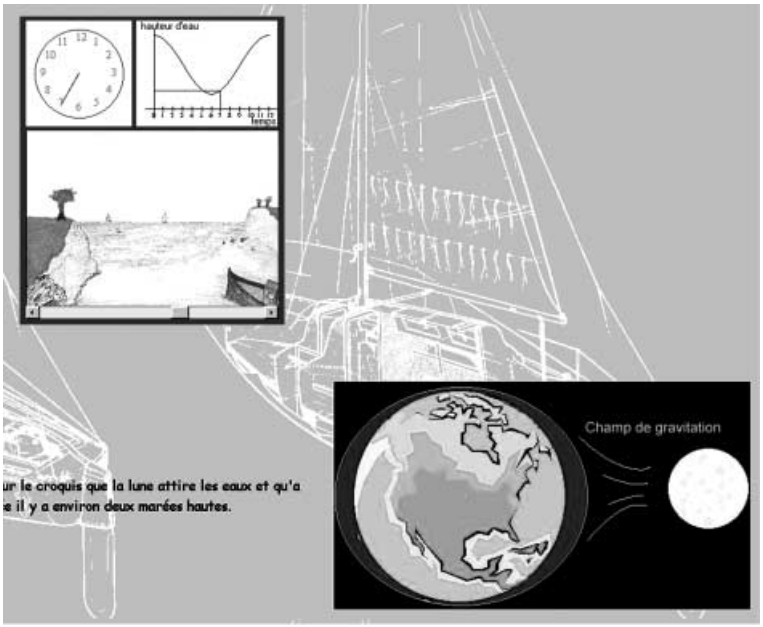


Fig. 7.13. Applet on tides

7.6 The Virtual Campus and Collaboration

Use by the Research Teams. The use of Internet presents the huge advantage of allowing distant work for trainers of different backgrounds, researchers in mathematics, in didactics, of the history of mathematics or teachers working on the same subjects. This work is impossible with the constraints of time and of location without the tools of communications. All the teams linked with the LAMIA have begun to use *Campus Virtuel*. Today, the obstacles of the limits of space and of time are relatively taken away by communication tools: networks working on common objectives are possible as shown by current events. Cooperative work is possible in the open university mode. The bet is the use of Internet so that research work and innovation are easily accessible and to encourage a large amount of teachers to do research and to have a reflexive practice throughout their professional life.

Presentation of the Software Program Virtual Campus. This software program *Campus Virtuel* [26] is an educational platform (created at the U.S.T.L.) in an experimental phase. There are five sequences of functions:

[26] see D'Halluin and alii "Usages d'un environnement médiatisé pour l'apprentissage coopératif"

- General functions for everybody.
- Personal functions.
- Group functions.
- Discussions.
- Creating discussions.

At present, the teams of the L.A.M.I.A. use their common resources, the public and the private boxes of everybody. They do not really use the discussion tools as support for collaborative work.

7.6.1 Collaborative Work

For educational technologies, general technological context and the Internet phenomenon have an important impact. It is obvious that the rapid generalization of Internet or the educational potential of Multimedia tools, create new opportunities for the development of *distributed learning*, in particular by their potential of universality and opening. Internet makes easier the distribution of training on a global scale. But many problems arise for the researchers in Educational Technologies and for the creators of Virtual Universities. Questions stem from the recent results of the research in the field of Educational Technologies and in that of human learning. For human learning, contributions came from several disciplines: psychology, cognitive sciences (with, for example, the concepts of Distributed Cognition [27] and with the ergonomic studies of Communication tools [28]), the Educational sciences with the concepts of constructivism, and the didactics of disciplines. New organizations of learning have appeared such as the distributed learning, which reconcile standard learning and distance learning to create new environments. Information and Communication tools with "computer supported collaborative work" will favor richer learning activities, by the access to a large amount of more authentic multimedia data, by simulations or animations. For better information on the problems in this field, one can read for example the latest *Journal of International Forum of Educational Technology and Society* of the *Educational Technology and Society on the collaborative work* [29].

On-line Collaborative Learning Environments. The L.A.M.I.A. workshop will study this theme with the trainers in the I.U.F.M. Along with this theorical study, experiments will be made, between trainers and also with the trainees, especially with mathematics teachers. An evolution of the initial training in the I.U.F.M. institutes is today available. At present, this training reproduces, with rare exceptions, the standard face to face relation

[27] see Roy D. Pea, "Practices of distributed intelligence and designs for education"
[28] see LEWIS "Apprendre conjointement: une analyse, quelques expériences et un cadre de travail"
[29] http://ifets.ieee.org/periodical/vol_3_2000/v_3_2000.html

between the trainers and the group of trainees. An experimentation will be done this year with a hundred PLC2 in mathematics in the I.U.F.M. The main objective is to give the trainees the possibility of exchanges about their professional experiences and to develop cooperative work. In the U.S.T.L., experiments with the same educational platform will also be developed. Several teams in the North of France are creating a new network on this question of On-line Collaborative Learning Environments.

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