A MULTIMEDIA LABORATORY IN A TRAINING COLLEGE IN FRANCE

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In the first part, this paper gives a presentation of the training colleges in France, called I.U.F.M. (Instituts Universitaires de Formation des Maîtres). This part is the translation, with his authorization, of a text written by Pierre Louis, Director of the I.U.F.M. of the Nord-Pas-de-Calais in France. In the second part, the training of mathematics teachers in the I.U.F.M. of the Nord-Pas-de-Calais is analyzed. In the third part, the creation and the role of the laboratory LAMIA (Laboratoire Multimedia, Informatique et Apprentissage) are explained. This paper only engages the responsibility of the author.

Part I

Training colleges in France

The I.U.F.M (*Instituts Universitaires de Formation des Maîtres*)

Organization of teaching in France

At first, one can consider that teaching in France is organized in three levels.

Primary teaching (1-st level) concerns the children from 2 to 11, compulsory education beginning at the age of 6. The teachers, called "the schools professors" who are in charge of this teaching, are comprehensive teachers.

Secondary teaching (2-nd level) concern the children and the teenagers from the age of 11 to 18. The teachers who are in charge of this teaching, "professors of secondary teaching ", have the responsibility of one, (for example : mathematics, or English,) or sometimes of two disciplinary domains (history and geography, English and French literature). The final exam of the secondary teaching, the high school diploma, called *Baccalauréat* gives access to higher education. One can observe the existence, in the secondary training, of a separation between several types of training : general training, technical or technological training, vocational training, training given in different establishments but with several schemes allowing the transition from a training to an other one.

Higher education forms the young people having finished successfully their

secondary teaching. The academic establishments have also a mission of research. The concerned teachers are, in their big majority, teachers and researchers and they are specialists of a discipline.

The initial training of teachers

The recent evolutions of the training of teachers

The recruitment of primary schools teachers has evolved quickly during the last thirty years from the level of high school diploma to the academic *baccalauréat* level + two years, and after to the *baccalauréat* level + three years.

The teaching staff of the primary schools and of the secondary schools are now recruited at the same academic *baccalauréat* level + three years.

The vocational training of these teachers has also been changed at the same time according to three political axes:

1. To bring together the training of all the teachers of the first and of the second degrees to give them a common culture and to make them aware that they take part in a common project : the training of all the young people to the best possible level.
2. To create a link between the theoretical training and the vocational training and to favour a culture of training all life long.
3. To give to universities a more important role which does not limit itself to the initial theoretical training of the professors.

The birth of the I.U.F.M.

To fulfill the objectives defined above, the first three experimental academic institutes for the training of teachers were created in 1990. The other institutes were all created the following year. There are twenty nine I.U.F.M. institutes, one in each county : for primary and secondary teaching, the national territory is divided in regional entities called *académies*, having an administrative and pedagogical role. These academic institutes for the training of teachers have replaced the different existing establishments until their creation where the teachers were formed separately : one for the primary school teachers, one for the secondary school teachers, and one finally for the teachers of the technical and professional secondary teaching.

The I.U.F.M. institutes are academic establishments of higher education which have, like the other academic establishments, a big autonomy as far as educational and administrative management is concerned. They are steered by a director who is, (with an exception), an academic assisted by two boards : a board of directors chaired by the Chancellor-Rector of the *académie* who represents the "State" (the employer), and a scientific and pedagogical council. The compulsory link with the universities situated in the same region is marked by the presence of the presidents of these universities in the board of directors, and the presence of representatives appointed by the boards of these universities to the scientific and educational council of the I.U.F.M.

In spite of their ten years of existence, the I.U.F.M. remain young establishments, still in an evolving process.

Some figures

In 1998-1999 the different I.U.F.M. institutes welcomed 81602 students and trainees : 57316 in the first year (one third for primary level, two third for secondary level) and 24277 trainees in the second year, for 78 different competitive examinations. These institutes had that same year 4177 posts of permanent teachers and 2790 posts of administrative or technical staff.

In 1999-2000 the institute of the *Nord-Pas-de-Calais* has 2192 students or trainees interested in the primary education and 4303 students or trainees interested in the secondary education.

The initial education for the primary and secondary school teachers

In initial training, the length of studies is of two years. The students who wish to become professors of the first degree or of the second degree fill in an application form to the institute; they all have at least the level of three academic years. The selected students enter the institute.

The first year is essentially devoted to the preparation of a competitive examination and for a lesser part to a first awareness of the teacher's profession under the form of a practical period in classes : they observe a teacher who is in charge of a class and can make some courses in the presence and under the responsibility of this teacher. The competitive examinations (a habit common to all the State public services in France) are organized by the future employer (the State) ; the examinations remain very theoretical and evaluate above all an academic level. However, there is a test concerning the professional capacities.

After the competitive examination, the students begin the second year in the institute. They are then probationers and get a payment as civil servants. The trainee has, this time, the full responsibility of a class. Tuition in second year makes a bigger room for several probation periods supervised by an experienced teacher. At the end of the second year, the I.U.F.M. has a system of validation under its own responsibility ; this system of validation is independent from a second one which follows and depends this time on the employer which is the State. This system is the one that decides on the definitive recruitment or not of the teacher. One has to note that the I.U.F.M. does not give a diploma ; success for its students at the end of the two years of studies consists in their recruitment.

Curriculum in the initial training of the I.U.F.M.

The first mission of the I.U.F.M. is naturally the mission of the vocational training of the new professors, a vocational training beginning during the first year

with an awareness to the teacher's profession and being strongly strengthened in the second year.

The practical training accompanied in the first year and the preparation of the oral exam of the competitive examination which allows to test the capacities of a candidate to link the discipline and its teaching in a class are a first approach of the professional training. Besides, during the first year, the training includes several tuition courses for the written and oral exams of the competitive examination.

In the second year, if further disciplinary information is given, the most important aim of the training is to establish links between the further information necessary for the exercise of teacher's profession (didactics of a discipline, psychology of the child and the teenager, sociology and philosophy of education, …), the practical competence that is to be acquired (management of class, communication, teamwork, …), and the real experience of the responsibility of a class. The system of validation resumes these three domains in the evaluation :

1. General professional training and disciplinary general training
2. Professional memoir
3. The exercise of the profession in the responsibility of a class

Validation is acquired only if each of the three evaluations is positive.

The professional memoir consists of a personal work for the trainee on his real experience of the teacher's profession. It is a work aimed at theorizing this experience, with a written report and a oral presentation in front of a board of examiners. It is then object of a contract between a professor and the head in charge of the memoirs in mathematics at the I.U.F.M. institute.

A part of the training can be individualized and take into account the project of the trainee. A part of the training can also be acquired abroad after agreement of the trainee and after agreement of the academic foreign establishment.

A strengthened mission : the continued education for the secondary school teachers

Since their creation, the I.U.F.M. have been recognized for its mission of participation in the continued education of teachers. However, this mission was notably strengthened two years ago. The institutes, within the framework of general objectives fixed nationally and of more precise objectives fixed in their *académie*, have now clearly to make a training plan for the teachers, on a yearly basis or more, with the participation of teacher trainers from different origins and with the academic establishments. By giving this new mission to the institutes, the political leaders want:

- To establish a link of continuity between the trainee teacher education and the continued education, each training becoming a time of a global process of improvement of knowledge along the career
- To strengthen the academic character of the training to maintain the teachers at a high level of knowledge and to favour the transfer of the results of the research in the field of the disciplinary knowledge and in the domains linked with the education or with the teaching professions

- To train together all the professors, primary and secondary school teachers of general schools or of technical and professional schools and to strengthen so the collaborations between the different orders of the educational system.

Important advances were already made in these different directions, but much still remains to be done, the cultures of the various actors being today so wide apart.

Research and pedagogical innovation in the I.U.F.M..

From their birth, the institutes have inherited of a pedagogical research, from an applied type, based on the experiments in the classes. However by lack of an established scientific community, by lack of an organized and critical confrontation, this applied research had many difficulties to be recognized and the diffusion of the results had a weak audience.

Without giving up these activities, particularly within the framework of training, the institute wished to develop a research having a real academic status and begin to create teams steered by researchers authorized to supervise research. This process passes through the collaborations between several institutes, or between an institute and a university to establish laboratories likely to be recognized by the national authorities. It passes also through a better defined policy of recruitment, in particular concerning the academic teachers' posts. Some research teams are, now, today recognized. The implementation of new teams is one of the priorities of the institutes in the forthcoming years.

International relations

One of the domains today developing in the institutes, after the research field, is the one of international relations. Like the other academic establishments, what is at stake is the finding of the means of consolidating the fundamental missions of teaching and research, in the exchanges of students and of teacher trainers, in the development of strong relations with the other foreign establishments having the same missions.

For the trainees of the institute, the exchanges bring them :

- A cultural opening, a better understanding of the other ones
- A better capacity to adapt and to be an actor of its traineeship
- A knowledge of the other educational systems and by comparison a better knowledge of the French system
- A progress in the knowledge of the other languages and more generally of the world.

For the teacher trainer of the I.U.F.M., international relations allow, beyond what was said for the students, the establishment of new links with researchers, the progress of the research, the sharing of expertise with the developing countries which wish to do so.

The teacher trainers of the I.U.F.M.

One of the strong peculiarities of the institutes consists undoubtedly in the variety of their trainers. These institutes benefit indeed from the contribution of trainers coming from all degrees of teaching : professors of schools, professors of secondary establishments, teachers of higher education, head of establishments, inspectors, … The complementary contributions of these people in terms of knowledge, of experience, of abilities, allow a diversified teaching and a specially rich training of the future professors.

If a part of these trainers are full time in the I.U.F.M., most of the trainers are FA (associated trainers) who have a part of their service in the I.U.F.M. and the other one in secondary establishments. These trainers are partly the managers of our trainees, but they also intervene in the education and specially in "general professional tuition" where they can make the link between theory and practice, and where their real experience of the teacher's profession gives them a legitimacy in front of the future teachers. The associated trainers are not recruited definitively but for a limited number of years.

In order to maintain the quality and the level of their trainers, and in order to recruit the new ones, the institutes set up a training for the trainers, often linked with research, which takes different forms : lectures, groups of thematic work, groups of production, workshop … The academic teachers' role is mainly to intervene in the training of trainers**.**

To the trainers aforementioned, we must add finally the teachers in post in a university who bring their contribution to the I.U.F.M., on an agreement or by an exchange of services with the university and that strengthens the academic character of the training.

Part II

The training of teachers of mathematics

These I.U.F.M. institutes are young institutions still in an evolving process. Before presenting the training of the mathematics teachers, in order to have a better understanding of the problems of the training, it is necessary to give some ideas on the changes brought by the I.U.F.M. in the training of teachers.

The changes brought by the I.U.F.M.

The contributions of the I.U.F.M.

The I.U.F.M. unified a system previously divided between two opposite categories :

1. The teachers' training colleges, called EN (Ecoles Normales) for the training of the primary school teachers. These centers had a historical role for the generalization of education, but were very isolated, without any opening towards research.
2. The universities where, in France, the career of the university teachers is based exclusively on research and where teaching is never the object of an evaluation. The universities are concerned with the academic preparation of the competitive examinations in the initial and continued formation, but with exceptions (such as the IREM), they are not interested in the vocational training of teachers ; this vocational training, for a long time, was not a subject of research.

The I.U.F.M. has brought an unification of the system of teacher training. The I.U.F.M. gathers all the actors of this training in the same institute. The professional dimension and the didactics of the disciplinary domains, in these institutes, begin to be taken into account in the educational system. It allows an opening towards the research methods, towards the link between basic research, research for development, and research for innovation.

The debates

All the current debates on the problems of mass-education, the questions of violence and of incivilities in establishments and all the discussions on the curricula in the primary schools and in the secondary establishments concern strongly the I.U.F.M. institutes. The new modalities of education and of learning emphasize on the autonomy of the learners and they show the importance of the personalized accompanying and of the helps for the pupils. They form the questions, for example, of mathematics taught to the young generation and the questions of the training of teachers.

Ten years after the creation of the institutes, a national consultation is in progress for the improvement of the training scheme for teachers. Some points in the debates concern the place of the written exams in competitive examinations, the modalities of vocational training, the introduction of information and communications technologies and the continuation of the training during all the career. Today, the competitive examination give a good evaluation of the academic level of the candidates. The possibility to evaluate their professional capacities before their recruitment in the I.U.F.M. is at the center of these debates.

The different I.U.F.M.

When the institutes were created, the ministry rules were adapted to appropriate modalities linked to local situations. Differences between the I.U.F.M. institutes of the different *académies* are very important. There are the problems of size which it is not possible to neglect but the main differences are also and especially in

the connections between the I.U.F.M. and the universities of the same academy. The biggest differences concern the training of the secondary school teachers. Some of the I.U.F.M. institutes have totally the responsibility of the preparation of all the competitive examinations while, in others, a great part of the training in the first year is given to the universities. The internal differences are also important. Some institutes give a real power of elaboration of the plans for the training to the disciplinary departments (eg to the department of mathematics) and an autonomy by awarding a budget to them. Some like the institute of the *Nord-Pas-de-Calais* have a rather centralized organization and privilege a interdisciplinary conception of the training ; the disciplinary departments have there mainly a role of proposal. Ten years after their creation, each institute is marked by the conceptions of its initiators.

The I.U.F.M. of the Nord-Pas-de-Calais

If one looks at the local functioning, one can notice that globally, the I.U.F.M. of the *Nord-Pas-de-Calais* has difficulties in finding its identity and that in spite of the will of the staff direction, too often, the institute still remains the juxtaposition of the former structures from which it inherits. The administrative constraints upon the institute are very strong. The place of didactics and of research on the training is too weak. Its training plans privilege a similar training, whatever the differences of the previous training of the trainees. The role of the university teachers in the conception of the plans of the training is small and the integration of the university teachers recruited in the local centers is difficult. The only place which is really recognized to them is the sector of research and more recently of the training of trainers. But the institute represents a progress in comparison with the previous closed structures from which it inherits by integrating all the categories of trainers working in the training of teachers.

Central questions

How to improve in the I.U.F.M., the coherence of the various elements of the training, these elements being often placed side by side today? How to develop a help to the trainees scattered on an geographic important zone without multiplying the travels? How to integrate the progress of research in the various domains of the educational sciences and of the didactics of mathematics in the training in the institute? How to facilitate the work and the contribution of trainers of different horizons on the same object that remains the training of teachers in the institute?

The initial training of teachers of mathematics

The competitive examinations

In France, the teachers of mathematics are recruited by two national competitive examinations, 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*) or the *agrégation* at the end of four years of university studies, (*maîtrise*), (for admission to the posts of the teaching staff of the high schools). Each of these competitive examinations contains two written exams. After the written exams, the available admissible candidates take two oral exams for admission. These competitive examinations are prepared at university ; for the *c.a.p.e.s*. trainees a probation in school is organized by the I.U.F.M. and the oral is partially prepared within the I.U.F.M.

Before the I.U.F.M., there was one year of preparation for the national competitive examinations at university and a second year in the C.P.R. (Regional Pedagogical Center) ; in the C.P.R., the trainees had the full responsibility of a class; experienced professors gave complementary classes. This C.P.R. was under the responsibility of the Regional Pedagogical Inspection of mathematics (I.P.R.).

The two years are now taken in charge within the I.U.F.M., with in the first year an important part of the training at university. In the second year, a new training has been organized : there is a 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 history of sciences are proposed to the trainees. This training is confided mainly to the professors of the former Normal Schools, (E.N. the establishments for the training of the primary school teachers). The teaching in a class has been integrated into the I.U.F.M. without big changes in its organization ; two periods supervised by a teacher in two different establishments give the trainees a better knowledge of the establishments. A memoir is compulsory for the trainees of the C.A.P.E.S., optional for those of the *agrégation*.

The responsibility of a class : Innovations, progress and problems

After his (her) success in one of the two competitive examinations, the student becomes a trainee (P.L.C.2) with a period of full responsibility of a class for the school opening ; only a part of the trainees had a probation during the preparation for the competitive examination, some of them not having followed a training in the I.U.F.M.. According to the school calendar, the trainee begins to work in his (her) class before his (her) training in the I.U.F.M. (or at the same time). In the establishment where they are teaching, they are helped by a mentor, a more experienced teacher of the same establishment. The role of this professor is to come regularly in the classroom of the trainee and to receive him in his own classes. He gives some advice to the trainee and helps him if there are any problems.

The trainees are scattered in all the regions of the academy ; they spend a lot of time travelling, because the other elements of their training take place in I.U.F.M. centers. The connections between the mentors and the I.U.F.M.. are often distant and limited to administrative questions. Several helps to the trainees are given : a training in the management of class during one day at the end of the first month ; the implementation of a system called mathematical S.O.S. for a additional visit for advice.

Difficulties

Some problems are due to the establishments where the trainees have their classes. Generally speaking these establishments are not chosen by the I.U.F.M. for the training reasons but proposed by the administrative structures of the academy. The establishments ask to have trainees because of a teachers' possible scarcity. This entails negative effects : the distribution of the classes among the teachers of the establishment taking place before holidays and the arrival of the trainees after, 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 aggravated by their inexperience of teaching : they often use a pedagogical material too poor which is not very interesting for the pupils.

The way to progress to articulate better the training and the education would be to let the I.U.F.M. develop its own network of establishments associated to the I.U.F.M. on common projects ; it would be then possible to have a more differentiated training, according to the types of establishments. To obtain a right of choice for the I.U.F.M. is an important inflection for the existence and the autonomy of the I.U.F.M. as an academic establishment.

The disciplinary training

The trainees receive within the I.U.F.M. a training by the professors of mathematics called FA (associated trainers) ; these trainers are recruited part-time for some years by the I.U.F.M.. Two trainers (one of middle schooling and one of senior schooling) work with a group of about thirty trainees for a disciplinary training in mathematics ; during two trimesters of the school year, they achieve about ten days of mathematical tuition. The tuition is given to the teachers who are chosen mainly by the inspection staff, on the basis of their abilities in their classes ; no knowledge of other subjects than strictly mathematical ones is required. The choice of trainers is not based on the participation of these teachers to the pedagogical research nor to the activities in training for adults. It is not obvious that the qualities required to be a teacher trainer are limited to the qualities of being a good teacher. The trainers teach their group without any exchanges between them and there is no transparency for the I.U.F.M. on the given training. This system is an individualistic system, while teamwork is required for the trainees. The I.U.F.M. of the *Nord-Pas-de-Calais* mainly applies a model of a rather classic face to face training with a help from experienced teachers. Research in educational sciences 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.

Professional general tuition

This training is, according to the statements of the authorities, one of the weak points of all the I.U.F.M. institutes. Beside the compulsory training, it is a training by some small units which are proposed to the choice of 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 technologic or professional) where they teach, and whatever their previous background. The majority of the teachers who are in charge of this tuition propose some parts of their previous teaching in the EN normal schools. For example, the training in the information and communications technologies involves the trainees of any levels for computer science, for two days. The training includes an initiation to a word processing, to surf on internet and to use a software program for documentation. For mathematics, the training is useless for the trainees who have a good training in computer science.

The memoir in mathematics

The memoir, of about thirty pages, is a collective work made generally by two or three trainees ; this memoir is a work of writing and of synthesis on a precise aspect of the professional experience of the trainees ; they have to define a problem met during their teaching and they are asked to lay down the questions precisely ; the aim of the memoir 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.

The trainees have to present orally their work in front of three examiners, (an academic, a secondary school teacher or a high school teacher and an inspector). This memoir is guided by teachers who are engaged in research works and these trainers have all themselves the experience of professional writing. A methodological help and didactical or historical complements are brought inside a workshop. The trainees have the freedom of choice of their subject which they have to submit for approval to the person in charge of the memoirs, (the author).

The memoir represents a real innovation of the I.U.F.M. and the guiding of the memoir is similar in the department of mathematics to a work of a direction of research. This guiding is often a fascinating work for the trainers who have to show to the trainees how research works can help them to examine their practice, how to make more quickly a profitable use of their experiences.

In 1999-2000 , 77 PLC2 have to write a memoir ; 31 PLC2 were guided by an academic, 28 by an associated trainer and 18 by a secondary school teacher or a high school teacher. Globally the guidance of the memoirs was done by 10 academics, by 8 associated trainers and by 8 other teachers. More and more, a collective guidance of several trainees is done by two or three directors.

Innovations brought by the memoir in mathematics

The peculiarity of the department of mathematics is the importance of the number of the academics engaged in the direction of memoirs ; during these last years, a team of direction of memoirs has been constituted, piloted by academics. The other peculiarity is the use of the technologies of information and communication as an important help, both for the trainees and for the trainers. The e-mail is an essential tool, the trainees being scattered all over the *académie* ; they appeal more and more to the network for educational on-line resources. For example, there is no compulsory

teaching of cognitive psychology in the I.U.F.M. and resources are accessible for the trainees in that domain on Canadian sites. The department of mathematics has begun for three years the creation of an on-line library : the quality of obtained memoirs allows to publish every year on the network a lot of these memoirs for the trainees or even more generally for the teachers of the *académie*. The use of the center of resources during their training in the I.U.F.M. engage the young teachers who just leave the I.U.F.M. to continue the work of the workshops and the creation of resources ; this is a very positive result of the memoirs.

The role of researches for the memoirs

In the *Nord Pas de Calais*, the role of the research in didactics and in history of mathematics is very important for the renewal and the improvement of the system of teacher education. Several teams of research, one in history of mathematics, the other one in didactics, and that of the Institute of Research I.R.E.M. are there very active, with links between these teams and mutual knowledge of works, at least by a part of the researchers. The history of the attempts of the researchers to integrate into the teacher education knowledge acquired in research is enlightening and shows that research in education is essential in the field of memoirs. That can be illustrated by several examples.

History of mathematics

The mathematics department of the IUFM of the *Nord Pas-de-Calais* have had a great deal of experience in teaching the history of mathematics. This takes place within the IUFM for initial teacher training and mainly within the IREM for in-service teacher training. The practice has changed and evolved over time.

Initially, at the IUFM, a twenty-hour course in history of mathematics was compulsory in either the first or the second year. This proved to be unsatisfactory both in the first year, where the students wished to devote all their time to prepare for an examination which does not require the history of science, and in the second year, where the teaching practice stage and the writing up of the memoir take up most of the energy of the trainees who, in any case, tend to feel that the training at the IUFM is too diversified. Consequently, the mathematics department decided to make the history course optional and to link it to the needs of those students who are preparing for their practice stage.

Nowadays, a course is delivered parallel to the seminars preparing for the memoir. The course deals with the history of a number of topics, such as algebraic equations, proof, numbers, measuring and vector calculus. The trainees can draw on these topics either for the preparation of their practice stage in schools or for the memoir. This turns out to be more satisfactory since the trainees find the history of mathematics course directly relevant to their needs. Rather fewer than half group take the course but, on the whole, these fifty-odd participants find it interesting. Trainees gain deeper understanding through working on their memoir, which is enhanced by

the work in schools teaching and by having followed the history course. The course at the *IUFM* provides a rich experience, and the participating trainees wish it to continue since such courses provide meaning for the topics they had to teach during their practice stage : introduction to algebra, initiation to proofs, presentation of different kinds of numbers, vectorial methods in geometry. The difficulties that still remain are rather connected with the whole structure of teacher training at the *IUFM*. For the present, linking the history course to the immediate concerns of the *practice stage* makes the course more valuable and effective for those who take the course, even though it do not reach all the trainees in any one year.

Didactics

In the same way, the contributions of the didactics are integrated into disciplinary complements and into seminars. The directors of memoirs and in particular the academics follow works in the didactics of mathematics such as those, for example, relative to the cooperative works of groups, to the scientific debate, as well as pedagogical experiments and their evaluation.

The creation of the C.R.E.A.M. Center of Resources for Education and Help in mathematics gives now a diffusion of the works which integrates this plurality of points of view in the training of the teachers : teachers, researchers in didactics or in history of mathematics, academics or teachers in schools and secondary school work in cooperation.

Generally speaking, along the years, the team of animation of the seminars was constituted by integrating directors who made researches in various domains, in a network which integrates more and more the contributions of the technologies of information and communication.

Part III

The LAMIA

Laboratoire Multimédia, Informatique et Apprentissage

The author of this paper was engaged in research on teaching of mathematics and on training of teachers since 1970, date of creation of the I.R.E.M., and in the I.U.F.M. of the Nord-Pas-de-Calais since its creation in 1989. Three years ago, she has created the C.R.E.A.M. with teachers engaged with her in the supervision of memoirs. She has also worked in the R.U.C.A. to produce multimedia resources in mathematics. These experiences have shown her the importance of a laboratory to create resources in an efficient manner. She began lobbying inside the

I.U.F.M. to create this laboratory. So, the C.R.E.A.M. is partly at the origin of the LAMIA. For the comprehension of the laboratory and of its research in mathematics teaching, some details about the research in the I.U.F.M. and in the mathematics training are necessary.

The research in education : the research policy within the I.U.F.M.

For several years, the direction of the research of the I.U.F.M. has given an active help and has provided funds to the research engaged by the trainers on the questions of training and this research can take multiple forms from punctual pedagogical researches to long term academic researches :

- Support for the trainers for the writing of theses.
- Punctual research like the researches on the practice, the educational innovations, the production of educational tools, the analysis of a training process.
- Long-term research by the research teams on a yearly or more programme in association with the I.N.R.P. (National Institute of Educational Research) or with a university team.
- Support for colloquiums and for workshops.
- Welcome of foreign colleagues
- The interest of an active participation of the teachers specialized in continued education has been recognized in the I.U.F.M. since its creation. More and more, it will be the training pattern.
- A Scientific Committee, formed by university teachers, by inspectors and by the trainers of the I.U.F.M. assesses the projects subjected to the I.U.F.M. for support, assesses productions before the publishing on the I.U.F.M. server.

The I.U.F.M. has done a numerous academics' recruitment in order to develop research and to improve the training of trainers. Mainly, the teams have their research which is transverse with regard to the disciplinary different domains. Until this year, the teams of the I.U.F.M. could not get the recognition of the same status as the teams of academic research. The current objectives of the I.U.F.M. is to favour a better structure of these works today scattered too much so as to favour their visibility and the emergence of teams of a critical sufficient size to obtain a recognition as a center of research.

Research on the teaching of the mathematics

During the last few years, between the trainers who are engaged in direction of the memoirs, in a contradictory and difficult way for colleagues coming often from different horizons, a network was created and these trainers have used more and more, between each other and with the trainees, the information and communications

technologies. This practice is also linked to their practice of research ; in France, several networks engaged in the renewal of education and of teaching are based upon these tools. The awareness of this evolution was at the origin of the L.A.M.I.A. laboratory. It is necessary to underline here the originality of the position of mathematics, due to the existence of a early current of research on the teaching of the mathematics, the institutes I.R.E.M. , which are structured at a national level.

The I.R.E.M.

In 1970, the France created an original network of institutes of research of the I.R.E.M., on the teaching of mathematics, to train quickly the teachers to the new curriculum of "modern mathematics". The institutes I.R.E.M. are set up in universities and they regroups teachers and trainers of any levels, (university, primary schools, comprehensive schools). Their tasks are mainly the following ones :

- They have to lead research on the teaching of mathematics
- They have to contribute to the initial training and to continued education
- They have to elaborate and to publish documents for the teachers and the trainers.

These institutes of research form a network steered by the assembly of their directors and the fourteen national committees give an impulsion to the research of the network group on several precise domains, such as geometry or analysis, or to the research relative to a level (university, primary schools, comprehensive schools), or to the research relative to the use of computers or of audiovisual tools, or to the more fundamental research in the domains of didactics or of history and of epistemology of mathematics. The network publishes a national journal *Repères I.R.E.M.* which reviews current research and which plays an important role toward the teachers of mathematics in France. To know how to articulate research and the training of teachers has always been the specificity of these institutes. Every year, five to ten national meetings (colloquiums or summer schools) from three to five days are organized by the national committees and regroup five to eight hundred teachers. They allow the diffusion of the research done by the local groups or by the academic teams on the teaching of mathematics. There is an important scheme of innovation-research at the level of the I.U.F.M. and of the *académie*. But the only mathematics have a national network.

The problem of the I.R.E.M. is their isolation : they remain an isolated creation for the mathematics only ; the authorities are always reluctant to generalize of the experiment. The interest of the active participation of teachers in pedagogical research is often underestimated.

The quality of the works done in the I.R.E.M. is expressed by an active participation of the researchers on the didactics of mathematics in international conferences, by the organization of European colloquiums in the history and in the epistemology of mathematics and by the translation of books published by the I.R.E.M. in this domain.

The existence of the I.R.E.M. led to a strong investment on the questions of training, even though a minority of members of the departments of mathematics in universities collaborated with the I.R.E.M. Quite naturally, the members of the

I.R.E.M. have worked with the I.U.F.M. since their creation. According to the regions, the local teams of the I.R.E.M. assume more or less the responsibilities of the teacher trainers within the I.U.F.M..

The I.R.E.M. of Lille is set up in the U.S.T.L. since its creation. The I.R.E.M. has developed research and has organized its training to adapt itself to the training schemes of the I.U.F.M.. In the *Nord-Pas-de-Calais*, the members of the I.R.E.M. intervene in the training of teachers and in the work of the memoirs in the second year. An original and very rich formula in the I.R.E.M. of Lille is the organization, each year, of two or three thematic days, each of them regrouping a hundred teachers. For example, the last subject was that of history of the scientific education where conferences, given by researchers of the C.N.R.S. (National Center of Scientific Research) or by foreign researchers were accompanied by workshops animate by teachers and local researchers. This type of modalities of training is also beginning to be developed in the I.U.F.M. for example in French.

The C.R.E.A.M., Center of Resources for Education and Help in Mathematics

The center of resources C.R.E.A.M. is a research team of the I.U.F.M. engaged in a long term programme, established to answer the problems evoked before. The purpose of this center of resources for the P.L.C.2 trainees is to propose some pedagogical situations which are rich and varied, in order to be interesting even for problem pupils. It has also to favour or to strengthen the understanding of the contents of teaching, to help the 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 of many years of experimental work as the practice of most of the members of the team proves it. The research goals are to add up their experience for young P.L.C.2 trainees by a work of systematization and of exchanges between the members of the team. The methodological choice focused reflection on some subjects by deepening their various aspects : historical, epistemological, didactical and pedagogical ones with a study of the existing documentation as complete as possible, and this site will be upgraded in the forthcoming years.

The team is composed of fifteen teachers of comprehensive schools and three university teachers and a PHD. The team prepares the experimenting of 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 debate, workshop.

What minimal conditions should exist to achieve the targeted objectives? What help, (at the same time 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 researches for example in didactics or in history of mathematics become accessible?

The realization of a data base, accessible on Internet has an obvious practical

interest to update the teaching in school and to offer a place for exchanges to the young trainees (and to the less young teachers). Creating the site on the internet was the opportunity of 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.

Besides, the use of the network presents the huge advantage of allowing the distant work for the trainers of different backgrounds, the researchers in didactics, of the history of mathematics or the teachers working on the same subjects, this work being impossible with the constraints of time and of location without the tools of communications. Teachers who have recently finished their studies in the I.U.F.M. take part in the network of this center.

Pedagogical networks in sciences and mathematics

Among the educational networks that have been created in France, the best known is called *la main à la pâte* ; it was initiated by the Nobel prize winner in physics, Georges Charpak for the renovation of the teaching of sciences in primary schools, (Charpak continued the current of renovation launched by Ledermann in the United States). It is animated at the same time by scientists, by researchers of the I.N.R.P. and by primary school teachers.

At university, the R.U.C.A., a network of the self-training centers within scientific universities launched a project of production called "On-line University". The objectives were to create resources for mathematics, physics, chemistry, biology and technology for the teaching of the first two academic years. Fifteen universities agreed to take part in cooperation to the creation of resources. The university of Lille is extremely engaged in this network and the author personally takes part in the production of some units of mathematics. The aim is to use resources to develop the individualization of training, to integrate the possibilities of simulations, of animations, and of the virtual experiments to facilitate the discovery and the understanding of the concepts in sciences.

Another regional network starts this year at the U.S.T.L. on the use of M.A.P.L.E. a software programme of symbolic computation. It regroups teachers and researchers of mathematics, of computer science and of physics from the regional universities. The aim is to study the contribution of these tools of symbolic computation to integrate the experimentation into the teaching of mathematics.

The information and communications technologies in the training

The political authorities realized that the French were far behind concerning the use of the information and communications technologies for education. A very important financial support, often in association with European funds was made to equip universities, primary schools and secondary establishments. The I.U.F.M.

institute of the *Nord-Pas-de-Calais* received important funds and its local centers are now well equipped. Many colloquiums are organized at several levels for the management staffs and for teachers. Altogether, the equipment of the establishments goes very fast. A national portal on internet for the visibility of educational resources on Internet has just been created for the primary and secondary school teaching and another one for academic teaching.

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 the technical follow-ups, the use of these classrooms by the teachers is at the moment a moot point. Not to meet the previous situation of the *Plan informatique pour tous* (computer plan for everybody) where some years ago, many establishments were equipped with computers which were used only by some colleagues keen on computer science in the general indifference of the other colleagues, is the topical question. (The same experience was also lived for audiovisual equipment).

A reflection on the previous problems is essential. The poverty of realizations of that time is explained partially by the state of research in cognitive psychology and by the performances of the software packages. At the early stage of its development, the computer-assisted training was linked with the behaviour theories and led to many realizations where the students were strictly guided on a route of questions and answers according to their previous answers. This aspect of "Multiple Choice Questions" has quickly found its limits in front of the difficulty for the 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. With the development of artificial intelligence, some expert systems have been created and the training intelligently assisted with 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 large use of these tools in the training possible.

The LAMIA

Why 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 internet of many data. They present a great interest for the training, by allowing much more freedom in the training, and a bigger initiative of the person who is learning. Reflection on the uses of these techniques for the training is still at an early stage, but one can bear in mind from the research on the practices some strong ideas.

The systems based on knowledge require a work of considerable elaboration.

To be really useful, they must be integrated into the training and not placed side by side.

To make the best of it, one has to privilege an active use of hypermedia by the trainee to solve problems or to make personal works given by their teachers.

If creation is sometimes the fact of a minority of teachers, full integration requires interest and membership from a lot of teachers.

This membership can not be obtained at once. Nothing will be made without the membership of the teachers and some speeches of technocrats saying that these technologies and the computers can replace the teachers have a very negative effect. The question is not of decreasing the role of the teachers but of allowing a richer and more interesting work, and a development of interactions between the trainer and the trainee.

These ideas have motivated the creation of a laboratory within the I.U.F.M. 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 led in other countries. The management of the I.U.F.M. allowed this creation by giving money taken from their own funds in the equipment of five computers powerful enough to make creations. Four persons are engaged full time in the laboratory : a teacher in the disciplines of the arts who is a specialist in video and of image creations, a history teacher specialist in the computer technologies for education, a technology teacher specialist in multimedia creation, a doctor of mathematics (young researcher) ; I assume half of my duty for the management of the laboratory and my work in the I.U.F.M.

The role of the L.A.M.I.A.

When it was created, the tasks of the laboratory were defined as follows:

- To lead activities of research and of development in the domain of the use of multimedia tools and of information and communications 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 appropriations of knowledge which they allow and the nature of the transmitted or acquired knowledge.
- To contribute to the creation of the new tools, whose use will be recognized as necessary, as well as to 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 to validate the capitalization of the reflection and of production. The workshop was dedicated this year to the contributions of cognitive psychology. Next year it will be articulated on simulations and virtual reality.

A Scientific Committee, formed by university teachers, by inspectors and by trainers of the I.U.F.M., evaluate 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. Because of the close relations which exist between mathematics and computer science, the tools and the teams of creation in mathematics are numerous.

A forum with limited access is at the disposal of the groups of research for their works.

The information and communication technologies in mathematics

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 with a forum and a federation of the teams of research in mathematics and of groups of trainers.
- With the use of useful software packages for mathematical word processing, for production of pedagogical documents with a good typographical quality, for the drawing and the experimentation in geometry, for data processing with the diffusion of the knowledge of didactic works on these tools.
- With the use of symbolic calculation today available on pocket calculators to develop the experiments in mathematics.
- As a tool of cooperative work between the trainees for the memoir and as a means of access to a library of on-line resources.
- As a tool of publishing and of call to the teachers of the region to experiment the on-line software programmes and of exchanges to improve the software tools.

Some software programs created by the teams of the *Nord-Pas-de-Calais*

- C.R.E.A.M.: center of pedagogical resources for the trainees.
- A6-3 : the electronic schoolbag of the secondary school teacher is a downloadable software programme ; it supplies an important data base on the curriculum, on the exams of the *brevet* (at the end of the secondary school) concerning the last ten years in France, with a set of lessons and of exercises for the four classes (from the first form to the fourth form) ; the teacher can develop it and modify it the way he wants in order to create his own database.
- LILLIMATH: discovery workshops for a use by the teacher in the classes ; *lillimath* received in 1998 the first prize of a national competition (*cervod*) of software tools for training.
- GÉOMÉTRIX: a help to the writing of the demonstrations in the secondary school ; this software programme, written in the programming language *prolog*, uses the techniques of artificial intelligence ; it had received the second price in this same competition.
- FUNCTIONS: the learning of functions in secondary technological schools ; this software programme allows an individual following-up of the works of the pupils and received the fourth price in that same competition.

- GEOWEB: a site presenting some creations made by the pupils themselves who created files on the solving of some open problems of geometry in secondary schools.
- BUTINAGE: software programme with a multidisciplinary use for research of the pupils on internet ; the teacher uses it to prepare themes of research and to select interesting sites for the work of the pupils.
- ON-LINE UNIVERSITY: the units developed by the academic teams are going to be at the disposal of the trainees and of the trainers in the centers of resources of the I.U.F.M.

The research of the LAMIA

The research of the L.A.M.I.A. are characterized by the following philosophy:

- The support for innovation and for creation.
- The cooperation for the creation of resources and for access to knowledge.
- The development of interactions between the creators of schools and the researchers.
- The experimenting of the tools with a return form the "rank and file" teachers, a return allowed by the tools of communications.
- The development of interactions between the trainers, (primary and secondary school teachers, university teachers), researchers in didactics and in history of mathematics.
- The distant work : tools for cooperative work do not require direct physical presence.
- The creation of pedagogical tools as a modality for continued education.

The first hypothesis of the laboratory L.A.M.I.A. is the importance of a real use of the 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 later a relevant use of these technologies with their own pupils.

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 proper to the research in their teaching practice. It is an important way to renew training of teachers and to form *reflexive practitioners*. The laboratory has a fundamental role in this process for the interaction between researchers and the "rank and file" teachers, for the training of teachers by the means of research.

To form the teachers by research

The practice of research in the training of teachers shows its positive aspects. The interesting character of the memoir in initial training, the importance of the existing network in France in the domain of research on teaching of mathematics shows that an evolution of the initial training in the I.U.F.M. institutes is today accessible.

At the moment, this training reproduces, with rare exceptions, the classic face to face relation between the trainers and the group of trainees. It is this model which is given today to the young teachers in the institute. One would like the trainees to learn to work in teams. To learn in a group to make the lessons that one will do alone in one's own class is not the way to give a meaning to teamwork, when taking part in a collective adventure with common purposes, one learns teamwork.

The developing of training by research is not an illusion. The question is not the developing of research aiming at producing some new knowledge during training. These types of research require time and a critical framework well adapted to the stable research teams. The question is the developing of an experimental and critical attitude. The question is the interrogation of one's teaching practice, the formulation of precise questions and of problems, the need to know the theoretical results established in the educational sciences or in the disciplinary domain, and the return to practice. The big interest of this research is the collective character of this practice, that learns to question what seems to be obvious, where one confronts his spontaneous convictions with the other points of view. These research develop a spirit of solidarity because of the aim of this work which is the production of resources which are to be published on the internet at everyone's disposal.

Today, the obstacles of the limits of space and of time are relatively lifted by the tools of communications : networks working on common objectives are possible as the current events show it. A cooperative work is possible in the open university mode. The bet is the use of internet so that the research works and innovation are easily accessible and the bet is the encouragement for a large public of teachers to be led to research, of a reflexive practice along one's professional life. It is possible and it is fascinating, whatever the institutional position of the teacher is.