Collective documentary activity as a mode of teachers' training : which methodological assistants ?

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1. ICT, geneses and professional development

The work presented here focuses on the general theme of teacher training dedicated to ICT integration. We consider like Ruthven (2008) that questioning ICT integration requires to take into account more general resources sets, with a general acceptation of resources including curriculum material (Remillard 2005), but also cultural artifacts (Adler 2000), and to examine their appropriation and transformation by teachers.

Our theoretical positioning originates from the instrumental approach, extensively used in mathematical didactics to study learning phenomena in technology-rich environments (Guin et al. 2005) and grounded on cognitive ergonomy (Rabardel 1995). This approach distinguishes an *artifact*, social and cultural product of human activity, which is available for a given user, and the *instrument* that s/he develops in integrating it in her/his activity, for a given class of situations, across different contexts. We study here teachers' documentary work: looking for resources, selecting, designing mathematical tasks, planning their succession, managing the available artifacts, setting it up in classrooms etc. In a perspective inspired by Rabardel's work, we introduce a distinction between a *set of resources* and a *document* developed by a teacher or a group of teachers from this set of resources in the course of documentary activities, for a given professional class of situations, through different contexts. We call this development process a *documentary genesis*, and consider it as central in the teacher's professional evolutions and development (Gueudet and Trouche to appear). In this perspective, integrating an ICT tool means to develop a document from a set of resources including this ICT tool. It naturally leads to the idea of grounding teachers' development programs on design of classrooms sessions by teachers, using sets of resources including ICT tools. This design is indeed likely to provide opportunities for the development of a document, within a genesis process.

A great amount of research has evidenced the potential of teachers' collective documentary work for professional development (Krainer 2003, Jaworski 2006, Miyakawa and Winsløw to appear), and integration of ICT tools (Lachance and Confrey 2003, Fugelstad 2007). It has also displayed the intertwining between these collective activities and the emergence of *communities of practice* (Wenger 1998). A community of practice can be a natural gathering; it can also be cultivated, in particular in the context of professional development programs. The members of a community of practice engage in joint activities, they share information about their common concern. The *participation* to a community is associated with a *reification* process: abstract elements of the practice are given a "congealed" form, they are represented for example by symbols, by words... Reification is a fundamental process, it prevents the activity to remain informal, it permits communication and mutual understanding. The relationship between participation and reification is dialectical: the participation generates the reification; and without reification, it is impossible to communicate, thus to participate in a community. Reification leads to the development of a shared *repertoire* of resources of the community, relative to the common practice: tools, stories... For a community

of practice engaged in documentary activities, reification is one aspect of the documentary geneses taking place in the community.
We observed above that the design of lessons, for individuals, is likely to permit genesis processes. Collective preparation of classroom sessions with a set of resources including ICT tools seems an even more suitable mode of teacher training to foster ICT integration, because of the reification processes taking place in communities.
The question we study here is: how to design such a training? In a previous research and teachers' training project (for secondary school mathematics teachers), the SFoDEM (Guin and Trouche 2005), we observed the simultaneous emergence of trainees communities of practice and of *models of resources*. These models, outcomes of the reification processes, were necessary for trainees to communicate, to design together, to share experiences. They acted as *methodological assistants*: sets of resources fostering and sustaining teachers' documentary work. Thus our question is, more precisely: which methodological assistants can be provided to the teachers for their collective activities, but also to the teacher trainers organizing the training?
We study an experimental teacher training project called Pairform@nce, directed towards the integration of ICT. We present this project, and our associated research and design project in section 2. We expose our findings in section 3, about collective work by teachers, but also by designers of the training programs, and the development of methodological assistants.

2. A research and development project, grounded on design in use.

Pairform@nce was set up in 2006 by the Ministry of Education in France after a successful experiment in Germany (Intel Lehren-Aufbaukurs online).
In this project, designers elaborate '*training paths*' for teacher trainers who will base their training devices on these paths. The training paths must observe compulsory principles: blended training using a shared platform; collective preparation of classroom sessions integrating ICT tools, and a succession of seven stages: introduction of the training, selection of themes and constitution of teams, co and self training, design of classroom situation, implementation in class, reflexive analysis, evaluation. The designers build within the frame constituted by these principles their own path, including description of trainers and trainee teams' activities along the seven stages, and any resource they judge helpful (some kinds of resources are indicated as compulsory by the national 'Pairform@nce training path specification').

Our research and design team (supported by INRP-National Institute for Pedagogical Research- and CREAD-Research Center on Education, Learning and Didactics) took the responsibility of the design of three paths for the training of secondary schools teachers. Two of them concern mathematics: individualization with e-exercises, inquiry-based teaching with dynamic geometry software; one is about geography and geology: learning with virtual globes. The designers of each path constitute communities of practice, with common work habits. They are assisted by researchers acting as "pilots"; and the research team comprises these researchers and one member of each designers team (figure 1).

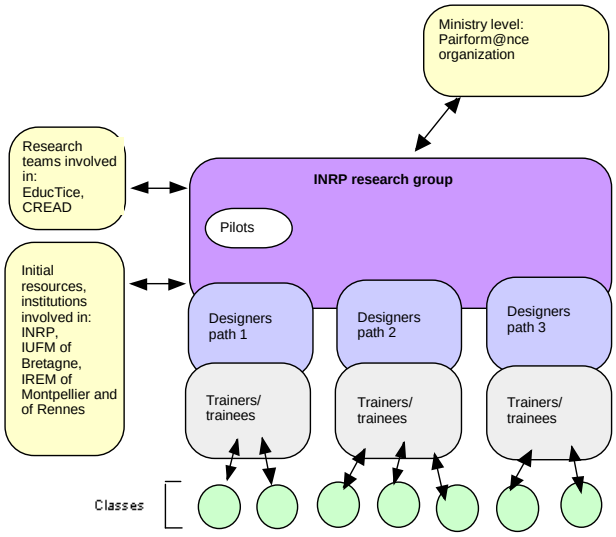

Figure 1. Structure of the research and design team

Our methodology is grounded on the idea that the design continues in usage (Rabardel and Bourmaud 2003). This idea entails a view of design closely connected with meta-design (Fischer and Ostwald 2005): users are active participants, and can act as designers. In such a perspective, the focus is on creating the conditions for users participation in design activities, and the socio-technical environments elaborated must support "mutual adaptation and continuous evolutions of users and systems over time" (Giaccardi and Fischer 2008, p.28). Methodological assistants share the same objective.

In our context, it leads to hypothesize that the appropriation of training paths requires assistance avoiding to much constraints, but also continuous integration of modifications proposed by trainees and trainers. Following these principles, we chose to simultaneously design and test the three paths. We observed and analyzed the associated experimental training devices, collected the trainees productions and trainees questionnaires. These observations led to evolutions of the paths; and other evolutions resulted from discussions in the team, comparison of the choices for the different paths, propositions of common choices by the pilots.

The results we present here are mainly about the training paths' design, and the appropriation of the trainers' resources by communities of trainees (appropriation by trainers will constitute a further step of the research).

3. Methodological assistants, communities of trainees and designers

The first kind of results we expose concern the paths designers. In their design process, assisted by the pilots, the three different communities of designers turned into one community of practice. From an initial set of resources: national specifications, experience of previous projects, tools elaborated for a given path, a common repertoire progressively emerged, and was enriched by co-designed resources. Some of these resources appear clearly as methodological assistants:

- Some resources were mentioned in the national specifications, but the design work led the designers to propose evolutions. For example, a "short presentation" is asked for, to provide a quick overview of the path's content. The principle of a "short presentation" was kept, but the categories evolved: a distinction between the objectives, and the means to reach these objectives was introduced; bibliographical references were added, as well as a list of contributors, and possible version number, to anticipate further evolutions of the path;

- Other resources were not mentioned in the specifications, and emerged simultaneously in different paths: an indicative schedule of the training; a description of the path's history (once again, in a perspective of future evolutions);
- More generally, along this work emerged a common form of assistance for the trainers who will design their training device following the structure proposed by the paths. It consists of tables describing the trainers and trainees teams activities, along with all the necessary resources and additional comments.

Finally, we retain from the observation and analysis of this design process the simultaneous emergence of a community of designers and of a *model of training path*, specifying a common form for the methodological assistance of the three paths. This model was designed in use; it belongs now to the designers' community repertoire. It provides methodological assistance for the designers, but also for the trainers and trainees following the path.

The second kind of results concerns trainees; we will focus on observations about the "Individualization with e-exercises" experimental training. Six teams of trainees were engaged in it; each team comprised between two and four teachers of the same school (teaching from grade 6 to 9, pupils between 11 and 15 years old). The training took four months, from the beginning of October 2007 to the end of January 2008, with four half days in presence, and a distant platform to communicate the rest of the time. The teams first chose a mathematical theme and a class level for their session. In the experimental training, only one e-exercises basis was proposed: Mathenpoche[1] ("Maths in the Pocket", shortened as MEP in what follows, Bueno-Ravel and Gueudet 2008). A teacher inscribed as "MEP's user" can constitute groups of students, and choose different contents for these groups amongst MEP's exercises. After a work on MEP, the marks of each student are recorded in a file providing the teacher with all the marks reached during the session. These features permit to organize individualized work: the teacher can program different contents, and access afterwards to an overview of the students' work. Naturally the individualized work can take other forms, for example individualized teacher's help for students working on paper while others are kept busy on e-exercises.

In the experimental training device, the half days of training in presence were devoted to:

1. Choice of the mathematical theme and class level by the teams;
2. MEP's technical features and possibilities;
3. Individualization: research results, reflection on possible class organization;
4. Final report.

Between the half days 3 and 4, the teams tested a first version of their session; one member of the team observed the other in class; if possible, a revised version of the session was tested and observed in another class afterwards. During the half day 4, a quick overview of each of the six sessions was given, and two of them were discussed in detail; moreover, the trainees filled in a questionnaire (bound to the trainers, but also to the designers and researchers).

Many results stem from the analysis of all the data we gathered; we only mention here the most striking of them in terms of documentary genesis, design in use and methodological assistants.

Some of the initial choices seemed to meet their objectives. The general principle of collaborative sessions design, and especially the cross-observation were appreciated by all the trainees, who declared that it significantly reinforced the common work in their schools, and that it yielded changes in their professional practices. A grid was proposed to assist this cross-observation; the trainees found it useful, some of them declared that it led them to observe

[1] http://www.mathenpoche.net

aspects they would not have noticed else (this is one typical aspect of the geneses: influence of the resource features on the subject's activity).
Naturally, the experimental training also led to observe necessary evolutions of the path. If the grid for observation was judged useful, on the opposite the grid for session description was considered as too complicated. The trainees did not use it in their session's preparation. After the detailed sessions presentations during the final report, it turned out to be appreciated by the trainees as a tool for discussing the sessions with shared categories, necessary for a mutual understanding. In fact the description grid was only quickly presented during the first half day. This was not enough to assist its appropriation by trainees. Thus the designers decided to propose in the path an additional half day, with a thorough study of two sessions examples, described along the description grid.
Another important necessary evolution revealed by the experimental training concerns the distant work. The distant platform was not used during the session's design. The teams working together in the same school had no particular need to use the platform to collaborate; they did not connect, and thus did not use the resources available on it (in particular, examples of other sessions). It led to an evolution of the path planning the constitution of teams of 4 teachers, 2 pairs in 2 given schools, with planned distant discussion times on a the platform's forum.
Appropriation processes clearly took place with some of the resources proposed for methodological assistance, while others did not meet their objectives. It yielded evolutions of the path, in a design in use process.

4. Conclusions

This research and design project is on progress. After a first year we retain the efficiency for teachers professional development of collective design of sequences involving ICT. The experimental trainings sustained the teachers' documentary geneses, yielding changes in their professional practices and collaboration habits. Another striking result concerns the principle of design in use. This principle was central in the paths design: discussions with the trainees led to improvements of the initial paths; reification processes within the designers community provided new tools for trainees, trainers and further designers.
We interpret these results in terms of methodological assistants. An efficient methodological assistant must provide enough help and simultaneously avoid a too tight management of the agents activity: this holds for trainees, trainers and designers.
The methodological assistants suitable to sustain subjects' collective documentary work can be considered in several ways as models: models of paths (given steps, in a given order); models of tools (description of sessions etc.). These assistants support both usage and design. They emerge from multiple back and forth movements, between design and use, between several members of a community of practice, between trainees and trainers. They evolve in an ongoing genesis process.

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