Integrating ICT in mathematics teaching, which assistance for the actors involved ?

Luc Trouche

LEPS (Lyon 1)

EducTice (INRP)

Luc.Trouche@inrp.fr

Canada-France mathematics congress
June 2008

1

Integrating ICT in mathematics teaching, which assistance for the actors involved?

1. The context (from different point of views, curricula, classroom mathematics, technological environments)… and one "example"
2. Multiple evolutions
3. New approaches
4. Designing resources for/from teachers, towards *methodological assistants*
5. Conclusion and research perspectives

1. Context

Evolution of mathematics	Evolution of curricula
Evolution of classrooms mathematics	Evolution of technological environments
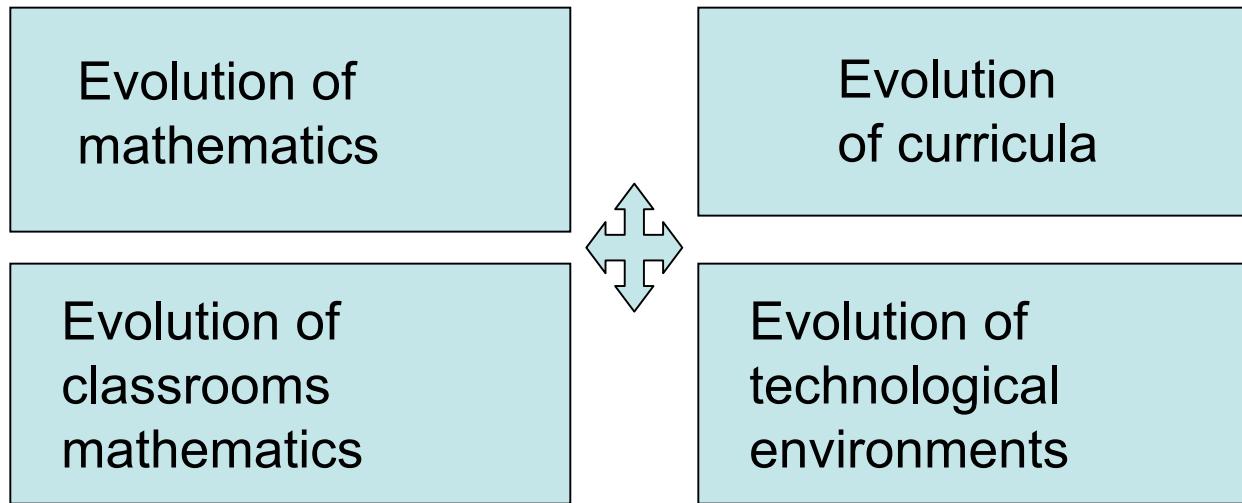
Mathematical problems, *orchestration* of classroom situations, assessment… modification of learning space and time *(questioning changes, Cazes)*

Coexistence *of advanced islands* (classroom situations de research et ICT integration) and of oceans of didactical and technological *stagnation (cf. Rogalski's remarks)*

Institutional (*practical* assessment at the French "baccalaureat" level), political et social (sciences learning and teaching) *tensions*

Mismatch between what mathematics is needed and what we teach (Taylor)   3

One example of advanced island…

CROME team:
http://educmath.inrp.fr/Educmath/partenariat/partenariat-inrp-07-08/crome/
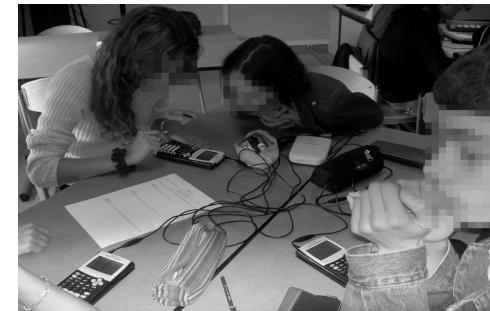
TI-Navigator, calculators network

Management of data and pupils screen by the teacher

Different configurations available:

✓ mosaic of screens;

✓ common space;

✓ quick poll…

Possible exploitation in physics or biology (captors), as well as in mathematics

Classroom = laboratory

Encourager la créativité mathématique et l'indépendance intellectuelle des étudiants (Buteau)

Multiple potentialities
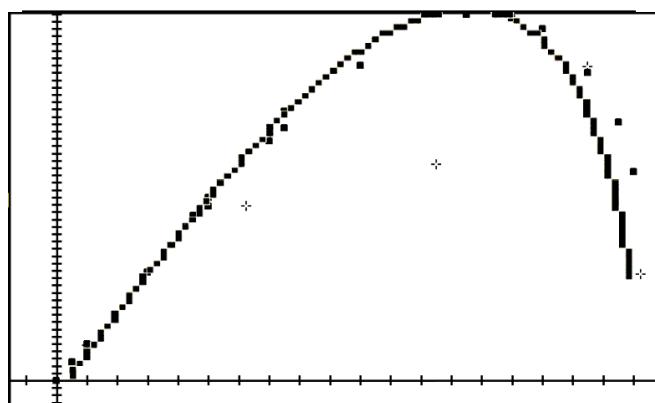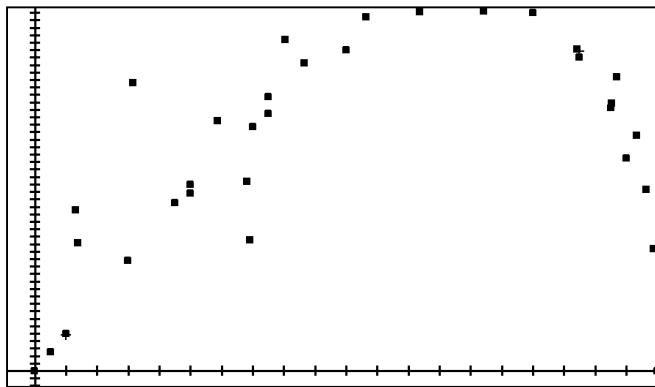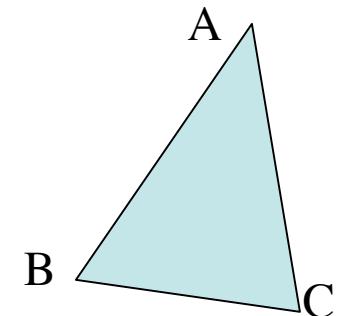
ABC is an isosceles triangle, AB = AC = 10 cm, area of ABC?

✓ didactical objective: the concept of function (of BC) ;

✓ networking of pupils;

✓ validating computations in small groups, sending data on a common screen;

✓ an object appears, personal "creation", but belonging to the classroom;

✓ Co-designing a mathematical object, modelling the given problem;

✓ many questions arise (approached measures, or errors of computation, curve or set of points, etc.)

✓ question of validation…

Complex choices…
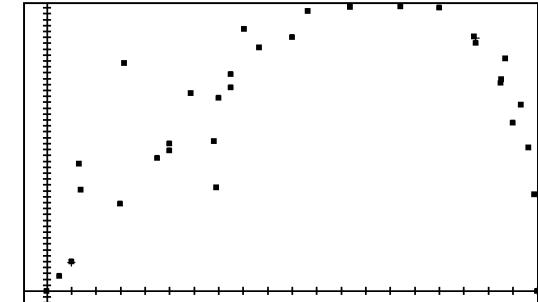
Complex didactical choices for the teacher(s?) :

✓ from an *orchestration* point of view (displaying - or not- pupils' names on the screen, common space or mosaic of screens…);

✓ from a more general point of view: managing the classroom situation (managing *scientific debate*, *recognizing* and *institutionalizing* new knowledge…)

An interesting a posteriori analysis (Hivon, Péan et Trouche 2008)

A viability coming from the collaborative work of a team
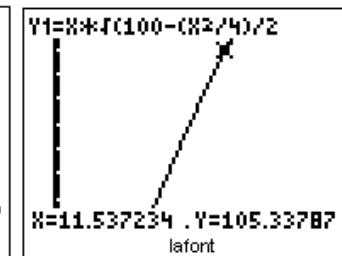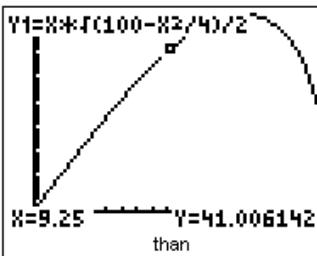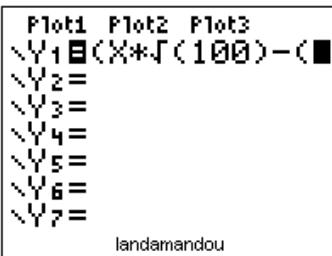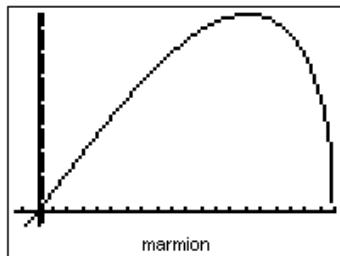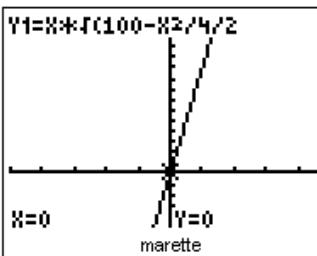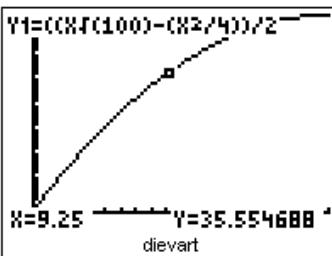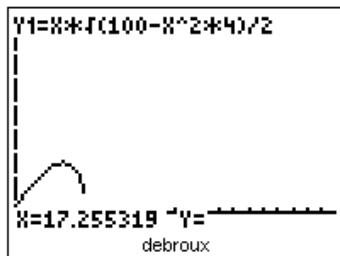
2. Multiple evolutions

From a research point of view:

- from an *optimistic* postulate to a *questioning* of ICT potentialities;

- from a problematic of *ICT integration* to a problematic of *designing interactive learning environment.*

From an institutional point of view:

- 1985: providing schools with *computers* ("plan informatique pour tous") et *long training sessions* (6 months) for *a few teachers*;

- 1995: providing schools with *software* and short training sessions for all (= many) teachers;

- 2000: providing teachers and pupils with *online resources* et questioning teachers training organizations;

- 2008: questioning resources (indexation, relevance, quality) et recognizing teachers' social practices (community, network, groups of common interest).

e-educ report (may 2008, French Ministry of Education)

2. Multiple evolutions

From teachers' point of view:

- *doing* his/her work (Clot 2007)

	Horaire de travail	Dont, hors présence des élèves
Premier degré	42h18	17h10
Deuxième degré	39h47	20h27

Tableau 1. Temps hebdomadaire de travail déclaré par les enseignants français (Ministère, 2000 et 2002))

- teachers' work, diversity of places, diversity of *missions and activities* (Pochard 2008);

- major evolutions of *collective* aspects of teaching, from "*dead assembly of teachers*" (Ribot 1899), to a *dynamic of collective* coming mostly from Internet usages (Pochard 2008);

- communities of resources designers, networks of users, an emerging trans-matters (Sesamath, Weblettres, Clionautes) and international (accord Mathenpoche - CASMI Communauté d'Apprentissages Scientifiques et Mathématiques Interactifs) synergy

3. New approaches

From the notion of *training* to the notion of *accompanying* :

✓ easier to change the *design of lessons* than to change *classrooms practices* (Robert 2007);

✓ necessity of an iterative and continuous work for designing, experimenting, adjusting resources, *notion of conception in use* (Rabardel et Pastré 2005);

✓ necessity of developing teachers' collective activities, ideally *communities of practice* (Wenger 1998), in which such a work could progress; dialectic participation/reification;

✓ complex interactions between pupils and teachers' work, cf. experiences of collaborative problem solving, involving both teachers and pupils (Sauter et al 2008);

✓ necessity of *models* (resources, network, organizations) to foster collaboration.

3. New approaches

Developing a holistic, dynamic understanding of the teacher's *activity*, within « what it involves, and what it is involved in » (Pascal)

Studying this course through teachers' *documentation*

A documentation is designed, built (with) from various resources

Document = *contract* between humans (Pédauque 2006)

A *documentary approach* (Gueudet and Trouche 2008), following (inspired by) the so called *instrumental approach*

Un ensemble de ressources

Un professeur
Ses connaissances, ses modes de travail

Instrumentation

Instrumentalisation

Axe du temps

Un document
Des ressources recombinées et un schème d'utilisation
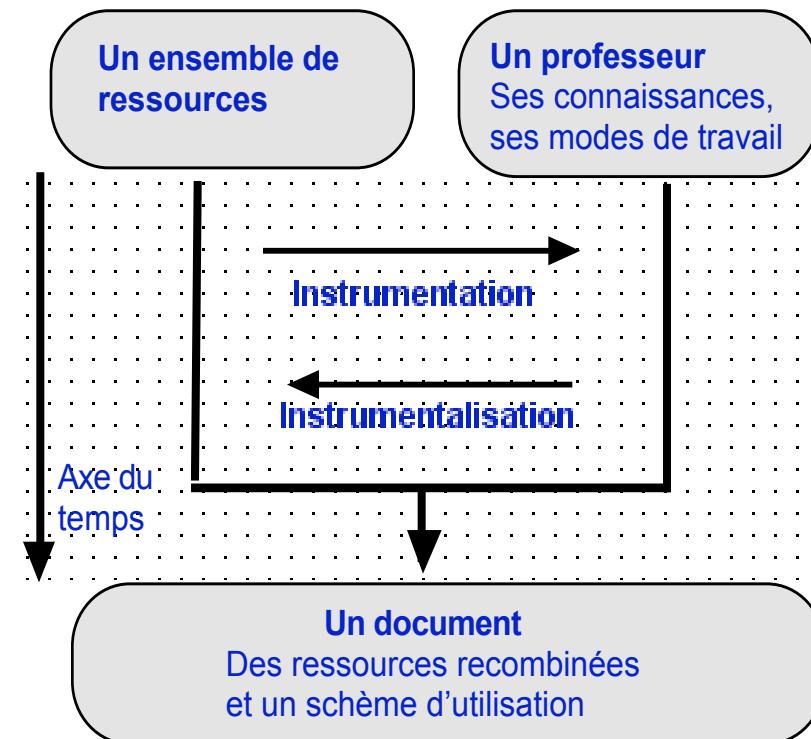
Cours de l'activité du professeur, activité finalisée (résoudre un problème d'enseignement), activité située (dans une institution, un collectif de collègues...)

4. Resources for/from teachers

SFoDEM project (2000-2006)

(blended teacher training for math teachers, secondary schools)

Initiated by the IREM of Montpellier

Objective : ICT integration

4 training groups (20 trainees, 3 trainers) on various themes, *designing* and *experimenting* resources (top-down and bottom-up)

A training committee coordinating the four groups, pointing out fruitful ideas and invariants both in the structure of resources and in the organization of each group

A continuous documentary work, face-to-face (3 days an year) and distance communication
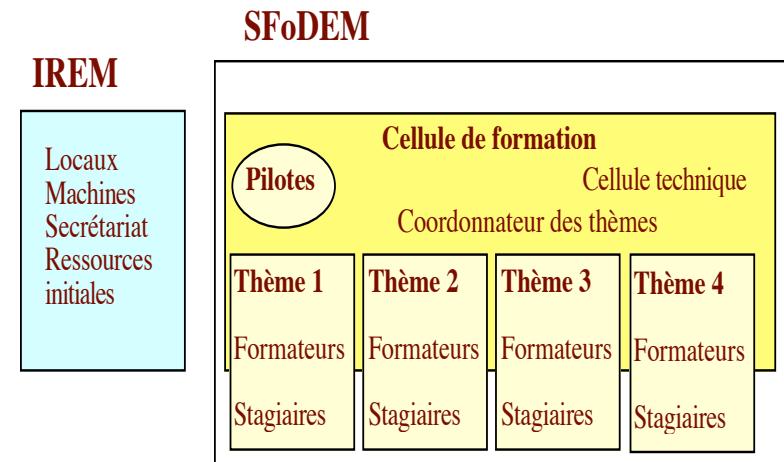
Genuine collaboration between mathematicians and mathematics educators [and computer scientists] (Lovric)

11

4. Resources for/from teachers

Documentary work, crucial steps

Ready made ressources proposed by trainers, *weak appropriation*…

Workshop for designing resources, from a *germ*, articulation of phases of design / phases of experimentation: the resources evolve

Participation and reification, co- emergence of communities, of *pooling of resources* and shared tools (*barometers, memories of work*)

Fruitful interactions trainers-trainees (= actors) (and pupils also)

Indexation	Student sheet	Teacher sheet

Technical sheet	Scénario	Reports
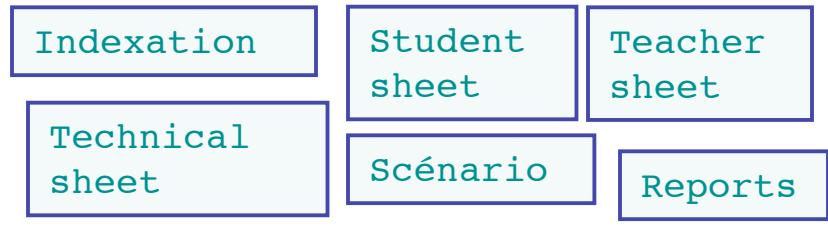
History of a resource, group « dynamic geometry »

Choosing a mathematical question
Reflecting on how a DGS could help
Reflecting on how the pupils could tackle the problem
Reflecting on possible scenario(s) for the class
Reflecting on some help for the teacher
Reflecting on the links to be established between resource sheets
Thinking to the *indexation*
Having in mind the necessary written reports about what happens

4. Resources for/from teachers

<u>Iterative design of a model of resource </u>(Guin et al 2008, Exprime 2008)

Shared experiments enrich each resource with elements *of assistance* of different levels, both *travel guide* (identification sheet, usage scenario, teacher sheet) and *log book* (traces of pupils work, CV…),

Emergence of a *model* of resources, condition for mutualization, an assistant for appropriating a given resource and designing new resources

The SFoDEM cédérom 2008, a methodological *assistant* for designing collaborative work (towards paths models)

5. Conclusion and perspectives of research

A change of perspective

The motor of professional development : the documentary work

> « … mathematics teachers' documentary work: looking for resources, selecting, designing mathematical tasks, planning their succession, managing the available artifacts, etc. We consider that this documentary work is at the core of the teachers' professional activity and professional development » (Gueudet and Trouche 2008)
>
> « In French, 'documentation pédagogique' is a widely-used term […]. In English, the closest terms would be 'teaching resources' (current in both US and UK) or 'teaching materials' (more current, I think, in the UK) covering both 'teacher resources' (in the sense of those aimed at the teacher' and 'curricular resources' and 'classroom resources' in the sense of those intended for direct use by/with pupils. In English, 'documentation' and 'documentary' tend to carry a more specific legal/official connotation. Of course, in the information science and computer software contexts, 'document' has a much broader sense, but this has not (yet) displaced the old language of 'resources' within the educational profession » (Ruthven, email 2008)

More precisely

Collaborative work, *rebalancing the conception on users' side,* emerging didactical questions through *reflexives* usages

Needs for methodological assistants: help for formalising a common language and for shared rules, help for building a common memory.

5. Conclusion et perspectives de recherche

<u>Other projects</u>

From the French Education Ministry, Pairform@nce (catalogue of training online paths) ; three courses already designed, first results confirming SFoDEM (notion of course assistant*)*

USB keys for new teachers, open access to a wide range of resources, no place devoted to collaboration…

<u>Research questions</u>

Methodological assistants and teachers' creativity

Documentary systems, mathematical and didactical organisations

Documentary geneses and teachers' *world* (Rabardel and Pastré 2005)

Individual / *common* documentary systems (Sabra 2008)

Bibliographie

Aldon G. et al (2008), Nouvel environnement technologique, nouvelles ressources, nouveaux modes de travail : le projet e-CoLab (expérimentation Collaborative de Laboratoires mathématiques), *Repères-IREM* **72,** english version at http://educmath.inrp.fr/Educmath/lectures/dossier_mutualisation/

Exprime (2008), Expérimenter des problèmes de recherche innovants en mathématiques à l'école, cédérom, IREM de Lyon et INRP, http://educmath.inrp.fr/Educmath/partenariat/partenariat-inrp-07-08/exprime/

Gueudet, G., Trouche, L. (2008), Vers de nouveaux systèmes documentaires des professeurs de mathématiques, in I. Bloch, F. Conne (dir.), *Actes de l'Ecole d'été de didactique des mathématiques*. La pensée sauvage.

Gueudet, G., Soury-Lavergne, S., Trouche, L. (2008), Soutenir l'intégration des TICE : quels assistants méthodologiques pour le développement de la documentation collective des professeurs ? Exemples du SFoDEM et du dispositif Pairform@nce. *Communication pour le colloque DIDIREM*, Paris, septembre 2008.

Guin, D., Joab, M., Trouche, L. (dir.) (2008), *Conception collaborative de ressources pour l'enseignement des mathématiques, l'expérience du SFoDEM* : INRP et IREM (Université Montpellier 2).

Guin D., Trouche, L. (2008), Un assistant méthodologique pour étayer le travail documentaire des professeurs : le cédérom SFoDEM 2007, *Repères-IREM* **72,** http://educmath.inrp.fr/Educmath/lectures/dossier_mutualisation/

Hivon L., Péan M., Trouche, L. (2008), D'un réseau de calculatrices à la construction collaborative du savoir dans la classe, *Repères-IREM* **72,** english version at http://educmath.inrp.fr/Educmath/lectures/dossier_mutualisation/

Pédauque, R. T. (coll.) (2006), *Le document à la lumière du numérique*. Caen : C & F éditions.

Pochard, M. (2008), *Livre vert sur l'évolution du métier d'enseignant*. Ministère de l'éducation nationale, en ligne à l'adresse http://lesrapports.ladocumentationfrancaise.fr/BRP/084000061/0000.pdf

Rabardel, P., Pastré, P. (dir.) (2005), *Modèles du sujet pour la conception.* Toulouse : Octarès.

Robert A. (2007), Stabilité des pratiques des enseignants de mathématiques (second degré) : une hypothèse, des inférences en formation. *Recherches en didactique des mathématiques* 27/3, 271-312.

Sabra H. (2008), Systèmes documentaires individuels et communautaires, étude de cas: le projet e-CoLab. *Mémoire de master HPDS*, Université de Lyon.

Sauter M., Combes M.-C., De Crozals A., Droniou J., Lacage M., Saumade H., Théret D. (2008), Une communauté d'enseignants pour une recherche collaborative de problèmes, *Repères-IREM* **72,** http://educmath.inrp.fr/Educmath/lectures/dossier_mutualisation/

Wenger, E. (2005), *La théorie des communautés de pratique, apprentissage, sens et identité*. Traduit de *Communities of Practice* (1998) par Fernand Gervais. Les presses de l'Université Laval.