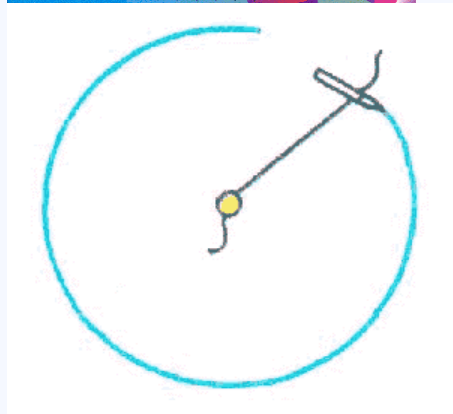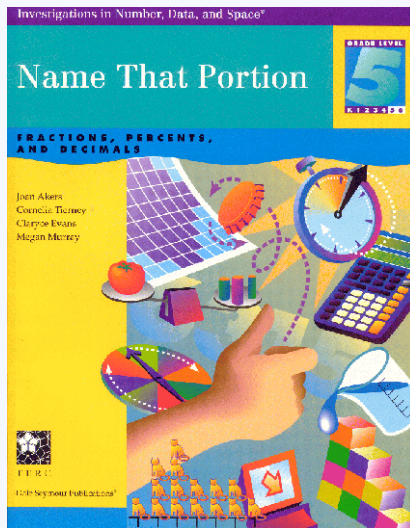# Resources, at the core of mathematics teachers' work

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Resources, for the teaching of mathematics

Text resources, mathematical tools

Designed for teaching, used by teachers

Resources, for the teaching of mathematics

Beyond material resources...

Resources, for the teaching of mathematics

HS 217a

Evolving resources

Focus of the conference

Interactions between teachers and resources; consequences, for teachers professional development

Evolutions brought by the Internet, in the resources, their design processes, their use, the teachers resource systems, and teachers professional development

A collective book
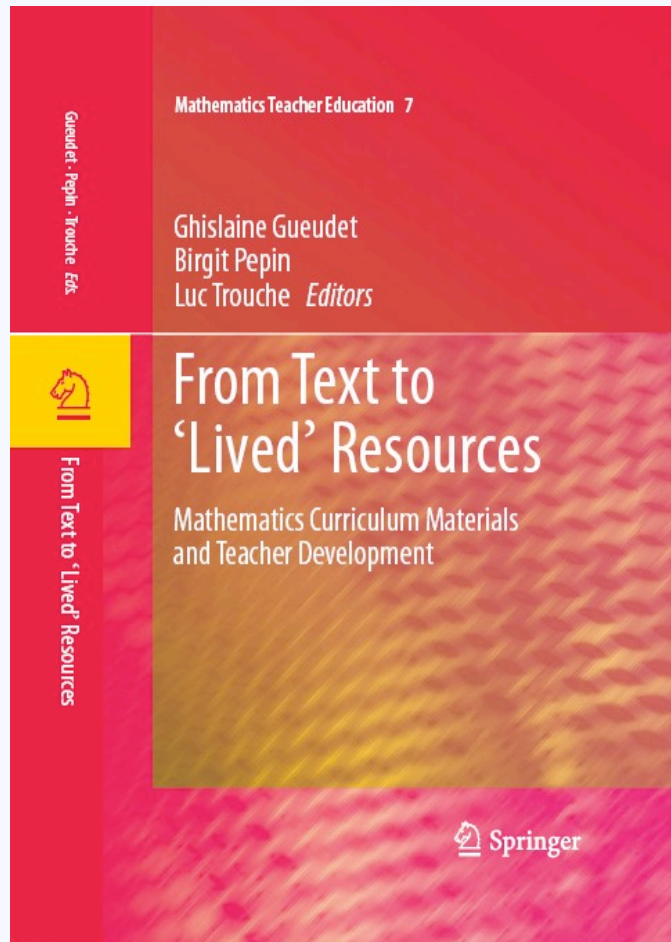
Edited by

Ghislaine Gueudet, Birgit Pepin, & Luc Trouche

Section 1: Teacher resources.

Section 2: Text and Curriculum resources.

Section 3: Use of resources.

Section 4: Collaborative use.

Outline

1) *Mathematics teachers resources*

2) *Resources use and teachers professional development*

3) *Collective documentation work and teacher education*

Mathematics teachers resources

A focus on resources exists in different research fields

Studies about textbooks, curriculum material (Pepin, 2009; Remillard, 2005)

Studies about educational technologies, ICT

Introducing a holistic point of view on resources conceptualisation of resources as anything re-sourcing the teacher's practice (Adler 2000); the resources can be material, or socio-cultural.

Mathematics teachers resources and Internet, evolutions

A profusion of available resources

A change in the design modes (resources designed for teaching):

Teachers groups, associations, design online resources for the teaching and learning of mathematics.

Teachers, as authors, test the resources in their own classes

Teachers, as users, send remarks to other authors

From bottom-up to more top-down processes?

Mathematics teachers resources and Internet, evolutions

A need for quality assessment

Quality definition?

Quality of the mathematical content

Quality of the presentation, ergonomy

Relevance, for the curriculum

Quality for a given teaching objective

Mathematics teachers resources and Internet, evolutions

The example of Intergeo: assessing quality of resources for dynamic geometry use

A questionnaire for users (Trgalovà al., 2010)

Nine dimensions: metadata, technical aspect, mathematical content, instrumental content, added-value of dynamic geometry, didactical implementation, pedagogical implementation, integration in a teaching sequence, ergonomic aspect.

Radio buttons: more on the left side to say that I don't agree, more on the right side to say that I agree

○ ○ ○ ○	I found easily the resource, the audience, competencies and themes are adequate
○ ○ ○ ○	The files are technically sound and easy to open
○ ○ ○ ○	The content is mathematically sound and usable in the classroom
○ ○ ○ ○	Translation of the mathematical activity into interactive geometry is coherent
○ ○ ○ ○	In this resource, Interactive Geometry adds value to the learning experience
○ ○ ○ ○	This activity helps me teach mathematics
○ ○ ○ ○	I know how to set my class for this activity
○ ○ ○ ○	I found easily a way to use this activity in my curriculum progression
○ ○ ○ ○	The resource is user friendly and adaptable

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Mathematics teachers ressources, evolutions *evidenced by a focus on* Internet ?

Design and use intertwined

Evolving collective aspects of teachers work

Two articulated evolutions: collective assessment of the resources quality, and continuous modification of the resources

No final product, but living resources

New roles for the teachers: assessing quality, contributing to design

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Resources use and teachers professional development: documentational approach

Research about students working with technology, the instrumental approach (Rabardel 1995, Guin et al. 2005)

An artefact: an outcome of human activity, designed for a specific aim.

An instrument: developed by a subject from the artefact, in a goal-oriented activity.

Instrument = artefact + scheme of utilisation

Extension of the approach: development of a documentational approach (Gueudet & Trouche 2009)

Teachers search for resources, combine them, set them up in class, revise them, share them: *documentation work*

Resources use and teachers professional development: documentational approach
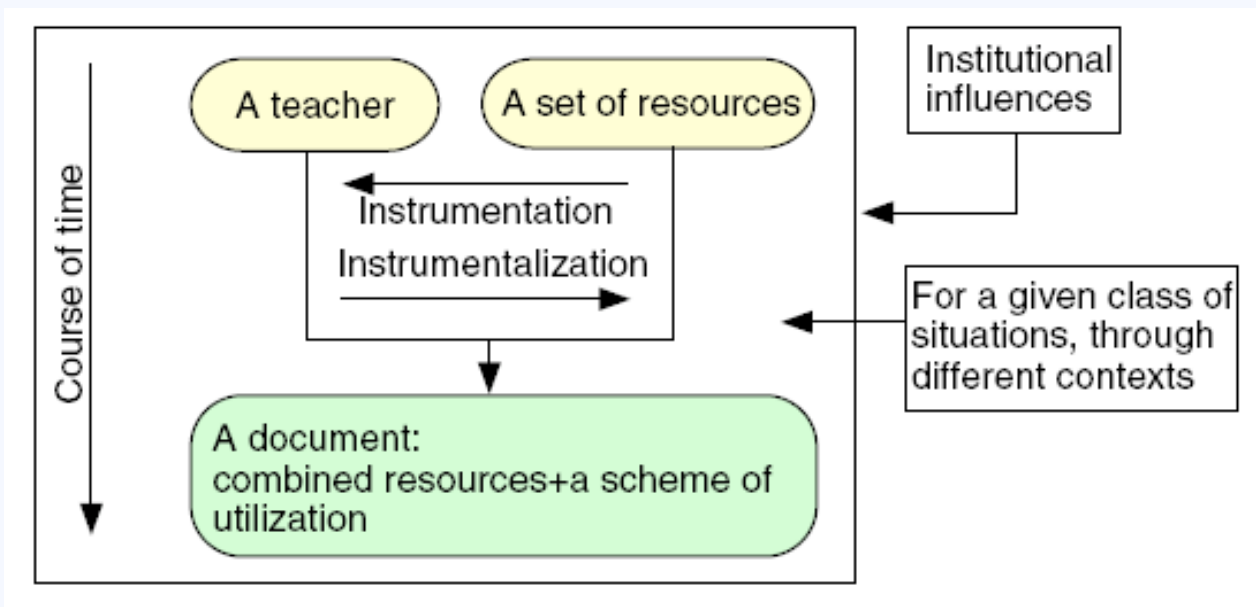
Documentational genesis:

a teacher develops a document from a set of resources

the document associates resources, and a scheme of utilization, in particular professional knowkledge

a double *instrumentalization/instrumentation* movement: the teacher shapes the resources, and the resources frame the teacher's choices, influence knowledge evolution

Resources use and teachers professional development: documentational approach

✓ Geneses develop across different contexts for the same objective; they are ongoing processes: a given document yields resources that can be engaged in further documentation work.

✓ Teachers develop coherent and structured resources systems and documentation systems

✓ Documentational geneses are central in teachers' professional development

Resources use and teachers professional development: documentational approach

Following teachers professional development, through geneses: methodology

- ✓ Need for a long-term observation
- ✓ In-class and out-of-class
- ✓ Collecting teachers resources, following their evolutions
- ✓ The teacher him/herself collects data (logbook)

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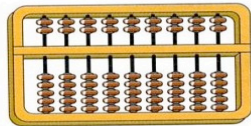# Resources use and professional development, an example at primary school

5 Numération : échanges

Grouper et échanger selon la règle « dix contre un », pour comprendre la numération écrite.

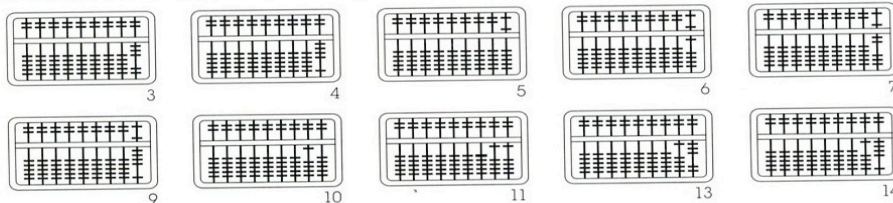**▶ Découverte**

Le boulier chinois

En Chine, pour compter, les enfants utilisent un boulier.

Regarde ce boulier chinois.
Toutes les boules sont éloignées de la barre de séparation.
Il indique 0 (zéro).

1. En observant attentivement les bouliers ci-dessous, tu peux découvrir comment les Chinois représentent les nombres.

Dans quel sens déplace-t-on les boules ? Quelle est la valeur des boules sur la première tige ?
Quelles boules utilises-tu pour représenter les nombres : 8 ; 12 et 15 ?
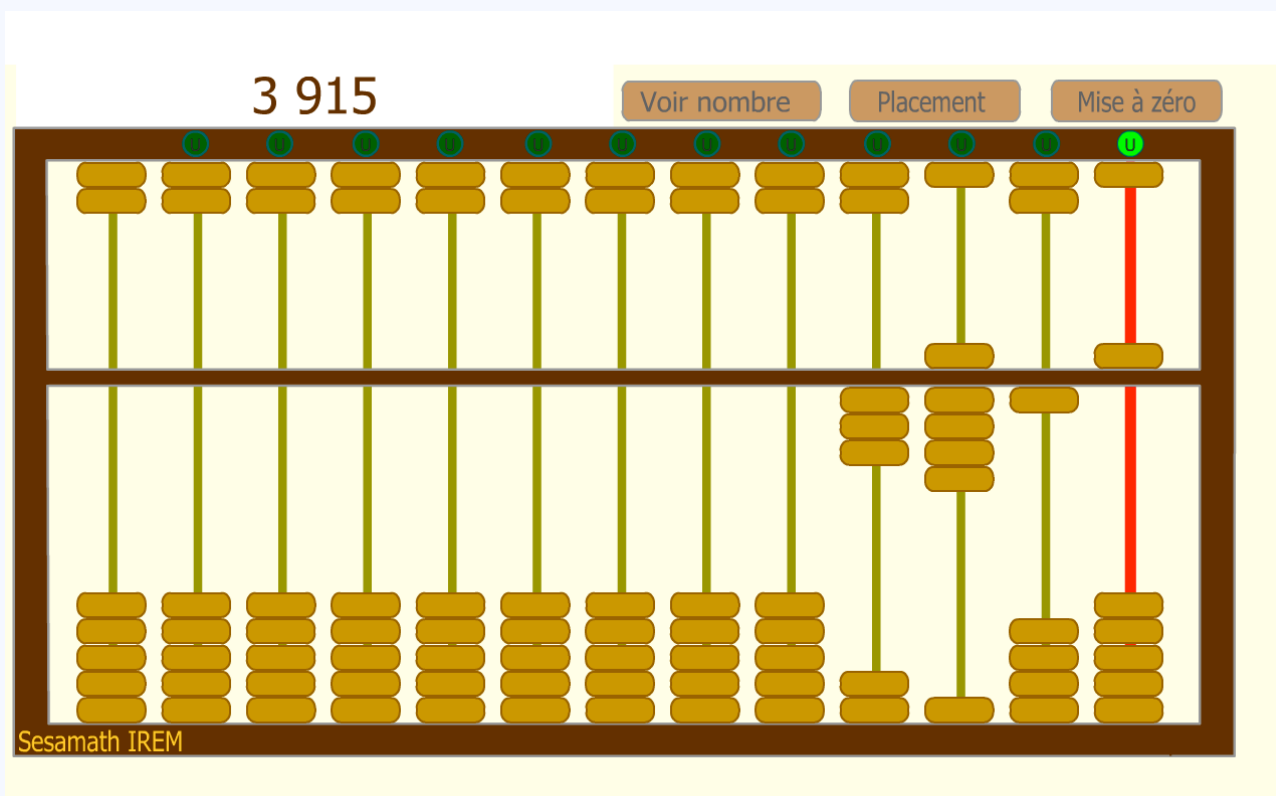
(Poisard et al. 2011)

Carlos, teacher in grade 3.

In the textbook, a lesson about numbers with the abacus

Difficult to set up with material abacii (not enough abacii ; difficulties for checking 20 students work)

The virtual abacus, developed by the Sesamath association

A course on numbers with the abacus

Objective of the course : working on the meaning of exchanges in numeration

8 sessions (1 hour each)

Functioning of the abacus, discovered by the students : investigation

Proposition of different ways to write the same number

Carlos observes that the students can « cheat » on the virtual abacus : need for written tasks

Resources use and professional development

Carlos developed a document, articulating the virtual abacus, written tasks, and professional knowledge.

The virtual abacus has been integrated in Carlos resources system – natural articulation with the textbook

Carlos choices depended on his professional knowledge : investigation, importance of exchanges in numeration

Carlos knowledge evolved, along his use of the abacus : knowledge about the use of software, and its articulation with written tasks; about didactical aspects of numeration

From professional development to the design of teacher education programs drawing on the documentational approach…

Collective documentation work and teacher education

Teachers belong to many 'collectives' (Gueudet & Trouche 2009), where documentation work takes place; under specific conditions, communities of practice (Wenger 1998) emerge in these collectives.

A community of practice develops a resource system (development of the community and development of the resource system are simultaneous).

Research on teacher education has evidenced the potential of teachers collectives, communities (Krainer & Wood 2008, Jaworski 2008).

All teacher education programs encompass documentation work.

The Internet offers new networking possibilities, to develop distant collective work (Goos & Bennison 2008, Borba & Gadanidis 2008)

Collective documentation work and teacher education

Example of the Pairform@nce project in France (Gueudet & Trouche 2011)

✓ A national teacher education project, concerning all disciplinary fields, primary and secondary school ;

✓ *Integration of ICT* ;

✓ Design of *training paths*, providing the structure of training device to be carried out across the country;

✓ These training device are *blended*, using a distant platform; they are grounded in *collaborative lessons design*.

Collective documentation work and teacher education

*Inquiry in mathematics with a dynamic geometry software: example of a training path*

Collective documentation work and teacher education

• Seven stages (like all the Pairform@nce paths): introduction, choice of a theme, self and co-training, design of the lesson, test of the lesson, reflection on the lesson, evaluation of the training.

• A training over four months (January-May), with three face-to-face days: introduction, constitution of teams, work on the software (day 1); discussion on inquiry in maths, preparation of the lesson (day 2); presentation and discussion of the lessons (day 3).

• Teams with 4 teachers. The lesson is tested and observed at least one time.

• Resources on the platform: lessons examples (studied in presence), description grid, observation grid, software guides, research articles…

• Communication via the platform: forums, folders…

Collective documentation work and teacher education

Following one team of four teachers
A lesson about angles and circles (grade 9), using GeoGebra
Introduction of the "angle at the center" theorem
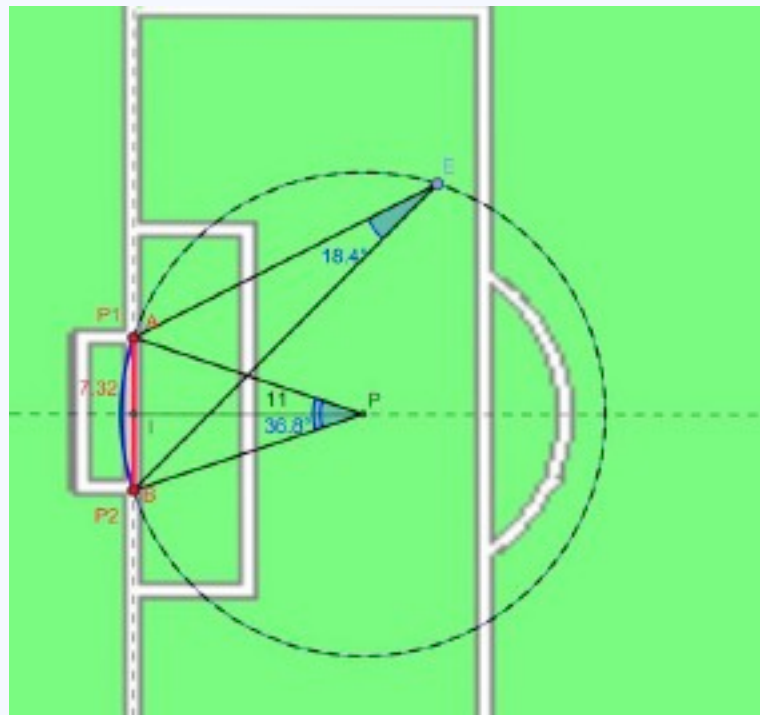
Presented as a soccer game
[AB] are the goals, P penalty point
A player *E* is on the circle of center P, radius AP.
Where should he be placed to have the best shooting angle?
Compare this angle, with the shooting angle at the penalty point.

Collective documentation work and teacher education

A documentation work, linked with professional knowledge concerning inquiry in mathematics

- The « inquiry-based » lesson must be inserted within the curriculum objective (time economy, conviction shared by the four teachers)

  Inquiry starts with a « real-life » situation (conviction of two members of the group, adopted by the two others)

- Teacher's help, during an inquiry-based teaching, must be carefully prepared, and must remain limited.

- An attention to language issues in mathematical modelling developed during the collective design of the lesson.

A long-term change of practice?

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Collective documentation work and teacher education

About distance teacher education, observed in Pairform@nce

Distant documentation work is possible, but..

Better communication, in the teams where teachers already knew each other

Face-to-face activities seem to play an important part, in the development of a community

Distance teacher trainers

Need for specific skills, for the trainers, to support the distant documentation work (Gueudet, Soury-Lavergne & Trouche 2012).

A possibility of up-scaling, via training paths proposed online, to build training programs ?

Which resources, for teacher trainers ?

Conclusion

Deep evolutions in the teachers resources, requiring new theoretical tools for analysis, and a new focus, for the research on mathematics teachers practices, mathematics teachers development.

Many further questions to study :

-"[Which] implications for design and coherence of materials if teachers are able to select tasks in varied orders ?" (an effect of digital material - question raised for ICMI study 22, task design)

-Which resources are *needed*, for the teaching of mathematics ? How can mathematics education research contribute to the design of such resources ?

-…..

Resources, at the core of mathematics teachers' work

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