Designing a mathematics teaching: digital resources and evolutions of teachers’ work

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A focus on teachers’ work with resources, why?

Resources are central in teachers’ work, they intervene in this work in class and out-of-class.

The digital means have deeply modified the available resources, their design mode, their possible use, and the collective dimensions in teachers’ work.
Two examples

1. Designing an inquiry-based teaching for Grade 9: the example of XXIst century alignment

2. Sesamath, a mathematics teachers’ association in France
Carnac alignments

A famous spot in Brittany…
A sculpture from Aurélie Nemours, in Rennes
Carole asks her grade 9 class:
“What is the “XXIst century alignment”? ”
XXIst century alignment, a teaching in 9 sessions

A search on the Internet, leading to questions raised by the students:
- Why 72 columns and not 3?
- Why did she choose these intervals between columns?
- Do the shadows join each other even at noon?

Starting point for an inquiry...
XXIst century alignment, a teaching in 9 sessions

The students choose to use software, for a modelling of the alignment: Google sketchup…
XXIst century alignments, a teaching in 9 sessions

The students choose to use software, for a modelling of the alignment: GeoGebra…
This situation lead them to work about:

- Proportionnality
- Functions
- Symmetry
- Angles and trigonometry….
The Sesamath association

An association of Mathematics secondary school teachers, designing free teaching resources: “Mathematics for all”
The Sesamath association

Created in 2001

- An important step: producing textbooks (from 2005 to 2008). Paper textbooks, with a free digital version (Creative Commons Licence), and online complements
- In 2010: a complete virtual learning environment: LaboMEP.
Mathenpoche, interactive exercises
(grade 4 to 10, access to students results for the teacher)

Vocabulary and notations

Question #1: Complete the following sentence:

We know that -5 is the input associated with 1 in the function \( f \).

Thus: \( f(\_\_) = \_\_. \)

ALIZANT Gaspard (6e A)

1 - Tables de multiplication
2 - Quadricalc division
3 - Méthode 2 p 29
4 - Vocabulaire sur la division
5 - Division posée classique (diviseur<10)
6 - Division posée classique (diviseur<10)
7 - Attention aux zéros!
8 - Petit défi
9 - Exercice 4 p 14
E-textbooks
(grade 6 to 10)
Labo MEP

Grade 6 textbook

Shared resources
Use of Sesamath resources, some figures

(end 2012)

- More than 18 000 teachers inscribed on Sesaprof
  (around 48 000 maths teachers in France)

- More than 15 000 000 connexions on Sesamath websites

- More than 1 000 000 students inscribed on LaboMEP
Outline

0) Examples
1) Questions about teachers’ resources
2) Investigating teachers’ resources
3) Results
4) Digital resources and teacher education
1. What is a resource for the mathematics teacher?

Textbooks, official curriculum, software, websites certainly are resources.

Some resources are designed for teaching, and others not: e.g. XXIst century alignment.

Some resources are material, and others not: a file sent by a colleague is a material resource; but the discussion with the same colleague is also a resource.

Adler (2000): a resource is anything likely to re-source the teacher’s practice.
Different kinds of questions about resources

- Resources content
- Their design mode
- Professional development
- Resources use by teachers
- Students’ learning

Diagram shows the interconnections between these elements.
Questions about resources: their content, their features, their design mode

- How are teaching resources designed: by who, with which objectives, which target public?
- How can we transmit a lesson, share it with colleagues? If we give too much details, they will not read it… If we do not give enough details, they will not understand it…
- How can we define, and assess, the quality of a teaching resource?
Questions about resources use, and professional development

- Which resources do mathematics teachers use? How do they choose them?
- How do teachers modify the resources they choose, how do they combine them, to create their own resources?
- Do some resources lead to evolutions of the teachers practices?
- Do teachers work collaboratively with resources? Do some resources foster teachers’ collective work?

How does the development of digital resources influence the answers to the previous questions?
2. Investigating teachers’ resources: research in mathematics education with the documentational approach

General perspective: the teacher is a designer of his/her teaching

The teacher draws on sets of resources: looks for resources, chooses some resources, transforms them, set them up in class etc.: the teacher’s documentation work

- The features of the resources influence the teacher’s work;
- The teacher’s professional knowledge influences the way he/she uses the resources, transforms them etc.
Research in mathematics education with the documentational approach

Along this work, the teacher develops a structured *system of resources*.

New questions:

- What is the content, structure, of mathematics teachers resources systems?
- How is a new resource integrated in the system?
- How do the systems evolve with the development of digital resources?
- In teachers’ communities, how do the individual and the collective resources systems interact?
Research in mathematics education with the documentational approach

A need to follow teachers in class and out-of-class, over long periods, to collect their resources. Individual teachers, and communities of teachers.
A research program started in 2007

Gueudet, Pepin & Trouche (ed. 2012)
Adler, Cobb & Visnovska, Drijvers, Kieran, Solares & Tanguay, Mariotti & Maracci, Remillard, Ruthven, Schmidt, Trigueros & Lozano, Winsløw...

A national research project started in 2014:
Investigating the resources of teachers in mathematics, physics, English, technology
3. Results

Example 1: Carole and the alignments

In Carole’s system of resources:
- Different software, she is familiar with technology, develops her own website
- Many resources linked with space geometry
3. Results
Example 1: Carole and the alignments

Importance of collective dimensions:

- Carole already worked previously with the fine arts teacher in her school
- She participates in a group about inquiry-based teaching

All these factors contribute to the integration of new resources in her system: the alignments + Google Sketchup etc.
Example 2: Sesamath

Investigating the design of the grade 10 e-textbook (Sabra & Trouche 2011).
Distant collaboration of a group of 14 teachers, between 2009 and 2013. Using: the official curriculum; the usual courses of the different members, a distant platform.

Initial intention: choose a list of keywords, corresponding to elementary skills (for example: “Represent graphically the square function” ). Characterise with these keywords pieces of course; interactive exercises, problems etc.
For the teachers using the e-textbook, this should permit to build many different coherent paths – the pieces of course, and the exercises, are seen as bricks that the teacher will arrange to build his/her course.
Example 2: Sesamath

**Damien**: I think that the course belongs to a precise chapter with three different sections. On the other hand, for the exercises we have to mix up everything.

**Michel**: But we need to choose exercises according to the progression. We can perhaps try to make something clear and simple for the teacher, concerning the course, the introductory activities and the basic exercises.

**Sandrine**: We need to have a **kernel** in each chapter, with the techniques of this precise chapter. In this kernel, we can not mix up things.

Finally: choice of a kernel in each chapter, with the introductory activities, the course, the basic exercises, corresponding to the same techniques. The more complex exercises can correspond to different keywords, they can be associated to different chapters.

Influence of the authors own courses…
Results about resources and their design mode

The design modes have deeply evolved with digital means.

More and more teachers design and publish on websites their own resources; the collaborative design of resources by groups of teachers is more and more important (e.g. Sesamath)

Some teachers look for “ready-made” resources; but there is also a need for “meta-resources”, helping teachers to design and share resources. (Fischer & Ostwald 2005)

The design-use articulation has evolved: the user of a resource can post a comment on a website, and the author can modify the resource accordingly.
Results about resources: quality issues

The evolution of design modes requires an assessment of the resources’ quality.

*How to define the quality of a teaching resource?*

- Ergonomy;
- Mathematics content (correct—corresponding to the official curriculum – likely to foster a rich mathematical activity of the students);
- Possibilities of modification by the user, preserving the coherence of the resource.

*Who assesses quality?*

In the Intergeo project (Trgalovà et al., 2010, resources around the use of dynamic geometry): a questionnaire for users. The quality of a resource depends on the user’s precise objectives.
Results about resources use

Use of resources by mathematics teachers in France
(no quantitative study – hypotheses, from several case studies)

Textbooks are still central, in teachers’ resources systems
The class textbook (shared with the students) is used for:
- Choosing the structure of the course (“progression”)
- Giving homework

It is more and more often associated with a digital version (pdf), projected in class by the teachers.

The publishers propose online complements, and sophisticated e-textbooks but these are not much used yet.
Results, about resources use

The use of software: dynamic geometry, spreadsheets, scientific computation has developed with institutional incitation (for example, a teaching concerning algorithms from grade 10 to 12).

The textbooks integrated this use of software, by proposing:

- in the paper version exercises and problems
- in the online complements digital files
Results, about resources use

Use of many other websites proposing activities with various kinds of software: institutional websites, associations (like Sesamath), personal websites etc.

In “complex tasks” (inquiry), students search for information on the Internet.
4. Resources and teacher education

Documentation work contributes to professional development, and can lead to evolutions of practice (in particular: collective documentation work).

Consequence: proposition of in-service teacher education programs, organised around the design of lessons by teams of teachers.

Principle present in the Japanese lesson studies.

Is it possible to use digital means to organise such teacher education programs (integrating a part of distant work)?
Resources and teacher education

Pairform@nce (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.
Resources and teacher education

Example of a training about “inquiry in mathematics with dynamic geometry”

Three days in presence, and distant work. Design of lessons by teams of teachers, experiments in class.

An interesting training mode, when the trainers are also the designers of the “training path”.

Two difficulties:

- Difficulties with the distant collaboration of teachers – they prefer face-to-face meeting. The local organisation did not permit the inscription of groups of teachers from the same school.

- Difficulties for trainers who did not design the training path to use it as a resource to build their own training.
Resources and teacher education

Teaching and Training with Digital Resources in Mathematics (eFAN Maths), a MOOC starting in November 2014

https://www.france-universite-numerique-mooc.fr/courses/ENSCachan/20007/Trimestre_3_2014/about

A work over 4 weeks (4h each week)

Week 1: Instruments
Week 2: Analysing students activity
Week 3: Analysing the teacher’s role
Week 4: Quality of resources

Teams of participants propose teaching projects, integrating digital resources.

Teams from the same school; the trainers are the designers…
Conclusion: a rich and complex situation

- A profusion of digital resources, but perhaps missing resources for teachers, for teacher trainers (*which resources are needed?*)

- Digital resources should allow adaptations for the user; constant improvement by the authors, integrating users’ remarks. But are the remarks integrated (Trgalova & Jahn 2013)?

- E-textbooks offering possibilities of adaptations, different paths: *more expertise required*, for the user of an e-textbook

- Need for more in-service training, and more research!
Thank you

Tak

Merci
References


