Digital resources
and
mathematics teachers' documents

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Outline

1. Digital teaching resources

2. Teacher's resources and documents

3. Documentation and teachers' communities

4. Conclusion

1. Digital teaching resources

« How could technology be best used to enhance traditional teaching? » (JEM 5th workshop question)

How could productive uses of digital resources in class be supported?

Digital resources for the teaching of mathematics

✓ Hardware: computers, interactive whiteboards;

✓ Software: spreadsheets, dynamic geometry systems;

✓ Online resources: a generalized availability, different kinds of websites (commercial, individual, collective, institutional).

Virtual Learning Environments, multiple associated resources.

Digital resources (for students, for teachers, for teacher trainers) yield evolutions in teachers' professional activity.

1. Digital teaching resources

A focus a secondary school mathematics teachers; national context, in France

✓ A generalization of connected computers equipment at secondary schools (one computer for 6.2 students from grade 6 to 9, for 4.4 from grade 10 to 12, Ministry study, 2006);

✓ No official website covering the whole mathematics curriculum, but a certification from the education ministry for online resources (not for textbooks!), projects: a national platform presenting possible resources, generalisation of Virtual Learning Environments in schools (2012);

✓ A very popular associative website, Sesamath (Mathenpoche, e-exercises covering grade 6 to 9; digital textbooks; Sesaprof, collaborative platform): 1.3 million connexions each month;

✓ Few teachers' collective work; fostered by Internet.

1. Digital teaching resources

Drawing on digital resources: which changes in the mathematics teachers' professional activity and development?

Different trends in educational research

Digital vs non-digital, a blurred border

- ✓ research about ICT (Ruthven 2007, Guin *et al.* 2005);
- ✓ research about curriculum material (Remillard 2005, Pepin 2007).

Research about teachers' professional activity and development

- ✓ teachers knowledge and beliefs (Ball *et al.* 2005, Cooney 1999);
- ✓ collective teachers' activity and professional development (Krainer 2003, Jaworski 2006, Goos & Bennison 2008).

2. Teacher's resources and documents

A new perspective on teachers' professional activity

(Gueudet & Trouche, online)

Previous research:

✓ uses by teachers of e-exercises bases (Bueno-Ravel & Gueudet 2007, Artigue & Gueudet 2008);

✓ICT integration (Guin *et al.* 2005); the SFoDEM (teacher training, collective design of lessons with ICT, Guin & Trouche 2005)

An exploratory study:

✓ 9 secondary school mathematics teachers, aged between 40 and 50, more than 10 years of teaching;

✓ various degrees of ICT integration (Assude 2007), and of collective involvements.

Interviewed at their homes (Margolinas *et al.* 2007), collection of their resources.

2. Teacher's resources and documents

A case study: Marie-Pierre, aged 40, teaching from grade 6 to 9, 14 years of professional experience. Use of dynamic geometry systems, spreadsheets, online resources; a digital textbook (Sesamath). An Interactive Whiteboard (IWB) in her class, students equipped with laptops, a VLE of the school.

Example of a course: introduction of the circle's area

III. Aire d'un disque :

Pour calculer l'aire d'un disque, on multiplie le nombre π par le carré du **rayon** du disque :

$$A = \pi \times r^2 \simeq \pi \times \pi \times \pi$$

On rappelle que : $r^2 = r \times r$.

Exemple : **Calcule l'aire du disque suivant :**

Le disque a un rayon de 3 cm.
On multiplie donc le nombre π par le nombre 3 au carré :
$$A = \pi \times 3^2 = \pi \times 9 = 9\pi$$
L'aire exacte de ce disque est 9π cm².

On peut obtenir une valeur approchée de l'aire du disque :
- en utilisant la touche π de la calculatrice, on obtient 28,274.... Une valeur approchée au centième près de l'aire du disque est 28,27 cm².
- en prenant 3,14 comme valeur approchée au centième près de π, on obtient 28,26 cm² comme valeur approchée de l'aire du disque.

2. Teacher's resources and documents

$$A = \frac{2 \times \pi \times R \times R}{2} = \pi \times R \times R = \pi \times R^2$$
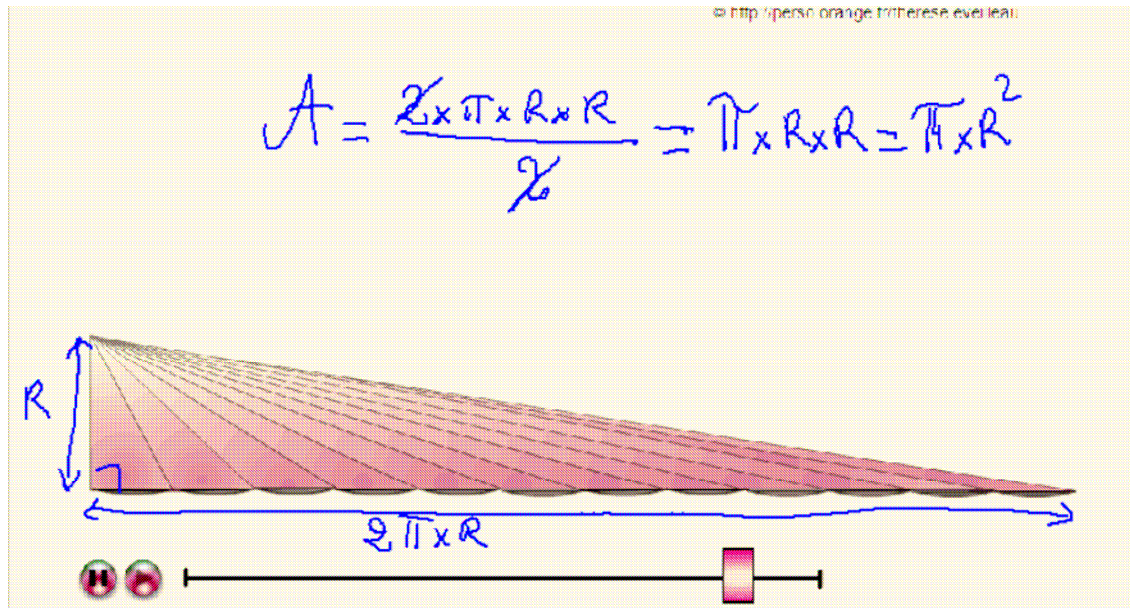
Resources: a word processing software to write the course, the digital textbook, a personal website with an historical presentation and a dynamic illustration with the circle unfolding and transforming into a triangle.

Marie-Pierre selects pieces of these resources, recombines them, sets up the course in class, writes on the IWB and records a paperboard for her students.

2. Teacher's resources and documents

Teachers' *documentation work,* in and out-of-class:

- ✓ looking for resources, selecting them;
- ✓ designing mathematical tasks;
- ✓ planning their succession;
- ✓ carrying them out in class;
- ✓ managing the available material, etc.

Teachers draw on sets of various *resources*

« Our conception of a *resourced teacher* then becomes a teacher acting with material and socio-cultural resources » (Adler 2000)

A dialectical relationship between available *resources* and *documents* developed by the teacher (a point of view inspired by the *instrumental approach* Guin *et al.* 2005).

2. Teacher's resources and documents
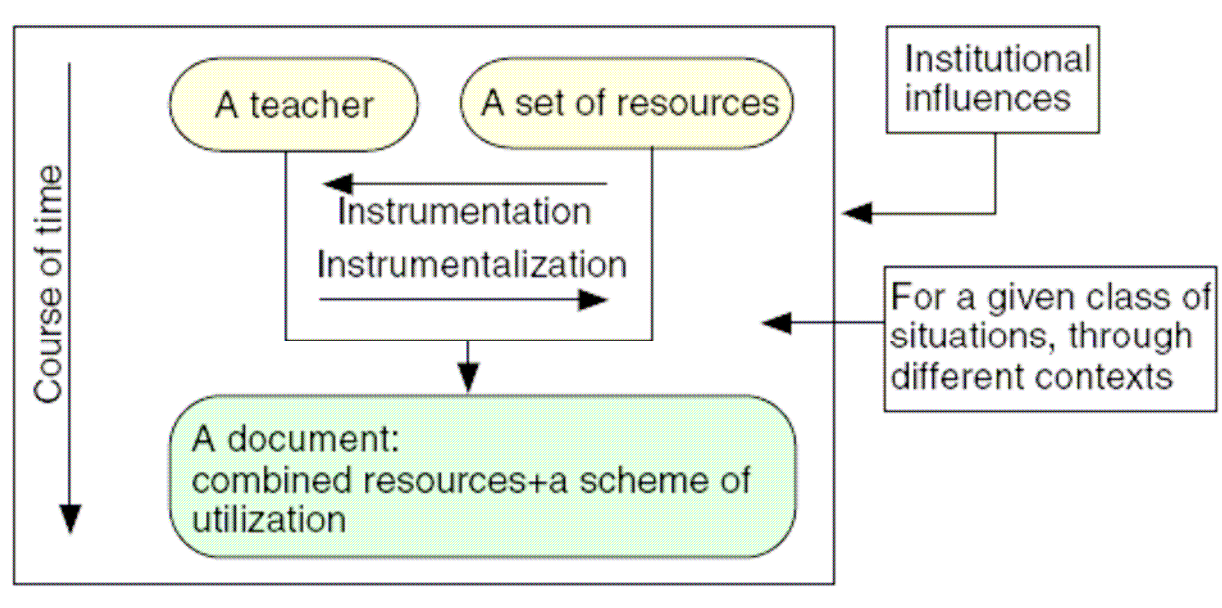
Documentational genesis:

✓ a teacher develops a document from a set of resources;

✓ the document associates resources, and a cognitive structure, professional knowledge;

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

2. Teacher's resources and documents

Marie-Pierre, introducing the circle's area, develops a document associating resources, and professional knowledge and beliefs:

- ✓ a new area formula must be justified by a cutting and recombining of the pieces to form a figure whose area is known;

- ✓ the circle's area must be linked with a previously known area (the triangle), and with the circle's perimeter.

Marie-Pierre's documentation work has been framed by these beliefs, and contributed to reinforce them.

Geneses are ongoing processes: *design continues in usage* (Rabardel & Bourmaud 2003), teachers are both users and designers of resources.

3. Documentation and teachers' communities

Emerging teachers' collective documentation work, linked with digitizing

✓ Observed in our interviews: two teachers have a "mathematics laboratory" in their school, with shared resources on a common computer; others participate to online forums; exchange courses with colleagues via e-mail;

✓ In France, development of teachers' online associations (Sesamath in mathematics);

✓ Projects grounded in online sharing of resources, of teaching experiments, in many countries: Enlaces in Chile, Enciclomedia in Mexico, A Geogebra institute in Norway.
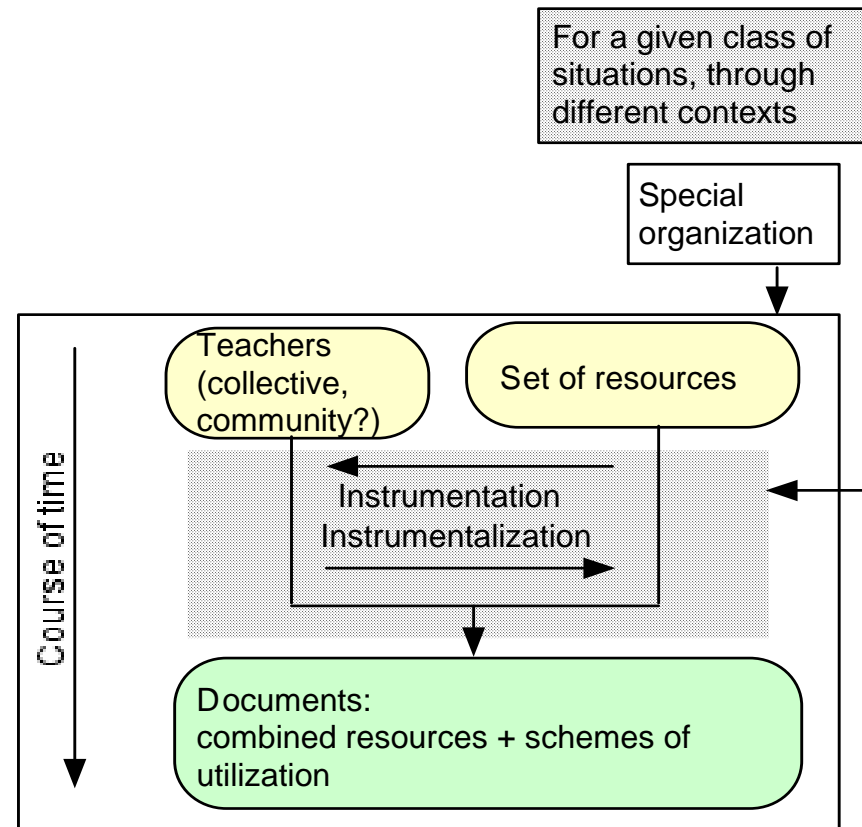
3. Documentation and teachers' communities

In *communities of practice* (Wenger 1998),

shared *repertoires* (objects, symbols, language etc.)

Collective lessons design: a promising mode of teachers' training (Jaworski 2006, lesson studies in Japan, Myiakawa & Winsløw to appear)

Professional development programs supporting *collective documentation work* involving digital resources?

A research, and a teachers' training project in France: Pairform@nce.

For a given class of situations, through different contexts

Special organization

Course of time

Teachers (collective, community?)

Set of resources

Instrumentation
Instrumentalization

Documents:
combined resources + schemes of utilization

3. Documentation and teachers' communities

Pairform@nce, a French national project set up by the Ministry of Education

pairFORM@NCE

✓ All disciplinary fields, primary and secondary school ;

✓ *Integration of ICT* ; following the German project "Intel Lehren";

✓ 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 on *collective lessons design*.

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formation

Parcours
de formation
Mathématiques
Enseigner la géométrie au collège avec un logiciel

> Introduction

> Sélection des contenus, formation des équipes

> Auto-formation et co-formation à distance

> Production collective d'une séquence ou activité pédagogique

> Mise en œuvre de la séquence

> Retour réflexif sur cette mise en œuvre

> Evaluation du parcours de formation

> Autre projet

3. Documentation and teachers' communities

A research and development project (INRP, CREAD, IREM of Montpellier and Rennes, IUFM Bretagne, Ministry of Education support) Production and simultaneous experimentation of 3 training paths. Example in mathematics: **Individualization with e-exercises.**

✓Aim : expand the trainees pedagogical practice by integrating e-exercises as a means for individualization;

✓A training over 3 months, with a distant platform, 3 days in presence;

✓Each trainees team designs a session using e-exercises and organizing individualization;

✓Cross-observations within the team, the initial session is modified and tested if possible a second time.

3. Documentation and teachers' communities

OBSERVATION OF A SESSION			
Date		Class	School
Session type		EEB used	
Objective			
Pedagogical organization			
Noted during the session			
	Description		Remarks
Mathematical content			
Students' activity			
Teacher's activity			
Individualization mode			
Role of the EEB			
Other			
Identification of ICT skills			
Students (B2i)			
Teacher (C2i)			
Session's Advantages/Disadavantages			
Individualization mode	Advantages		
	Disadvantages		
Use of the EEB	Advantages		
	Disadvantages		
Other			
Suggested modifications			

Example of a resource proposed in the path: observation grid

3. Documentation and teachers' communities

Individualization with e-exercises: outcomes of the experimental training.

✓ the experimental training fostered collective work in the trainees schools, emergence of trainees communities, with their repertoires;

✓ the cross-observation was appreciated by all trainees, who drew on the grid provided (appropriation, genesis);

✓ the grid for session description was appreciated as a means of communication during the final report; but it was not used to prepare the session;

✓ the trainees did not use the distant platform during their preparation.

A modification of the training path on the national platform, a *design in use* movement.

4. Conclusion

Digital resources in mathematics: design, use and training issues

New articulations between design and use: design in use, users are also designers.

A new perspective on teachers' professional activity: the documentation work is crucial; documentational geneses are central in the teachers' professional development.

New forms of collective teachers' work.

Consequences for teachers' training: organizing collective lesson design, and supporting it (meta-design, Fischer & Ostwald 2005).

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WG7 "Technologies and Resources in Mathematical Education"

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